APPENDIX I

GEOTECHNICAL REPORT

(Technical Appendices to this report are on file at the City of San José Department of Planning, Building and Code Enforcement, 200 East Santa Clara Street, San José CA, 3rd Floor)

GEOTECHNICAL DOCUMENT
IN SUPPORT OF THE
ENVIRONMENTAL IMPACT REPORT

COYOTE VALLEY SPECIFIC PLAN
SAN JOSE, CALIFORNIA

SUBMITTED

TO

DAVID J. POWERS AND ASSOCIATES

SAN JOSE, CALIFORNIA

PREPARED

BY

ENGEO INCORPORATED

PROJECT NO. 5969.3.004.01

AUGUST 18, 2006

Project No.
5969.3.004.01

August 18, 2006

Ms. Jodi Starbird
David J. Powers and Associates
1885 The Alameda, Suite 204
San Jose, CA 95126

Subject: Coyote Valley Specific Plan Area
San Jose, California

GEOTECHNICAL DOCUMENT IN SUPPORT OF THE ENVIRONMENTAL IMPACT REPORT

Dear Ms. Starbird:

We are pleased to submit this technical document characterizing the general geologic/geotechnical conditions of the Coyote Valley Specific Plan (CVSP) area in San Jose, California. This report is a compilation of our previous geotechnical assessment and limited fault exploration to assist you in preparation of the environmental impact report (EIR) for the CVSP.

We are pleased to have been of service on this project and are prepared to consult further with you and your design team as planning progresses. If you have any questions regarding the contents of this report, please do not hesitate to contact us.

Very truly yours,

ENGEO INCORPORATED

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INTRODUCTION

Purpose and Scope

The purpose of this document is to summarize the geotechnical/geologic site characteristics identified from our prior studies as they relate to development within the Coyote Valley Specific Plan (CVSP) area. The two previous studies include:

- Preliminary Geotechnical Evaluation; September 2003, revised June 2004
- Limited Fault Exploration; July 2006 (Appendix A)

The information presented herein is intended to assist in the project-specific Environmental Impact Report (EIR) process.

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Existing Setting

The development area of the CVSP would ultimately be a community of up to approximately 70,000 to 80,000 residents, depending upon the number of persons per household and the actual mix of the different residential densities and typologies expected. The urban design approach for the valley focuses on the guiding principles of a sustainable, transit-oriented, walkable community, containing a mix of uses that utilize land efficiently. The Plan includes uses such as work place, residential, retail, and mixed use development, structured/shared parking, new roadways, including a main multi-functional parkway and an extension of Bailey Avenue to the southwest towards the Almaden Valley, an internal transit system with a connection to a proposed multi-modal transit station on the west side of the existing Caltrain line, a lake, the relocated and restored Fisher Creek, an urban canal, libraries, schools, services and utilities, parks, trails, and playfields. The Coyote Valley Greenbelt (between Palm Avenue and Morgan Hill and on the east side of Coyote Creek, extending to Highway 101 between Metcalf Road and Morgan Hill) will remain as a permanent non-urban buffer between San José and Morgan Hill.

The roughly 7,000-acre study area is located in a portion of the Santa Clara Valley referred to as the Coyote Valley, which is a broad, relatively flat valley floor that drains to the northwest. The primary drainage course is Coyote Creek, which is located between Highway 101 and Monterey Highway. A secondary drainage course, Fisher Creek, is located along the southwest side of the valley and generally follows the alignment of Santa Teresa Boulevard. The main CVSP site elevations range from about 240 feet above mean sea level, where Coyote Creek discharges to the northwest of the study area, to about 360 feet above mean sea level along Burnett Avenue.

In addition to the CVSP study area, improvement and/or realignment of Bailey Avenue to the west of the study area is being considered in conjunction with the current planning process. Characterization and discussion regarding Bailey Avenue are included in later sections of this technical memorandum and are separate from the discussion regarding the main CVSP study area.

GEOLOGIC SETTING

The study area is located in the Coast Ranges geomorphic province of California. The Coast Ranges are dominated by a series of northwest-trending ridges and valleys that have been formed by faulting and folding of the earth's crust. A published geologic map of the vicinity (Figure 1) by Wentworth et al. (1999) indicates that the Coyote Valley is underlain by basin deposits and alluvial deposits ranging from Pliocene to Holocene age (about 5 million years old to recent time). Studies by Rogers and Williams (1974) indicate that these sedimentary deposits vary from about 200 feet thick at the northwestern end of the study area to more than 400 feet thick in the southeastern end of the study area. Bedrock around the perimeter of the study area is mapped predominantly as Franciscan Mélange and serpentinite, roughly 70 to 150 million years old.

The study area has experienced a wide variety of previous usage. From a geotechnical engineering standpoint, uses of most interest include agricultural and quarrying. Historical research and our site reconnaissance shows the majority of the site as agricultural land, including vineyards, orchards, and vegetable farming. Quarrying for sand and gravel is evident east of Monterey Highway but appears to be inactive.

Soils and Bedrock

Based on a review of regional geologic maps, interpretation of aerial photographs, and our reconnaissance of the site, the Preliminary Geologic Map (Figure 2) for CVSP was prepared. Discussion regarding the geologic units anticipated at the site, as shown on the referenced map, is as follows.

Existing Fill (Qaf). Existing fills (Qaf) are evident along various roadways, along the railroad adjacent to Monterey Highway, on some existing building pads, in levees adjacent to some creek channels, and in fill areas and stockpiles of material associated with the previous quarry activities in the eastern portion of the site. With the exception of the fills in the quarry area, existing fills are probably less than 5 feet thick and are anticipated to not have been moisture conditioned or compacted.

Colluvium (Qc). Areas of thicker soil cover in swales that extend upslope of the main valley floor are shown as colluvium (Qc) on Figure 2. Based on observation of surface conditions, the colluvial soils appear to consist predominantly of silty clay that has moderate to high plasticity, resulting in an anticipated moderate to high expansion potential.

Basin Deposits (Qhb) and Levee/Alluvial Deposits (Qhl, Qhf2, Qpf). The relatively young sedimentary deposits in the Coyote Valley have been mapped by Wentworth, et al. (1991) as Holocene basin deposits (Qhb), Holocene levee deposits (Qhl), older Holocene alluvial fan deposits (Qhf2), and Upper Pleistocene alluvial fan deposits (Qpf), as shown on Figure 2.

Holocene basin deposits (Qhb) are located in the western portion of the study area. These deposits generally consist of silty clay sediments that have been deposited on flood plains where flood waters drop fine-grained material. Holocene levee deposits (Qhl) are located adjacent to Coyote Creek, where during flooding, fine- to coarse-grained materials were deposited along the creek banks and gradually accumulate in the form of a natural levee. These deposits vary from clayey silt to sand and gravel, and are sometimes found to be loose or poorly consolidated. Older Holocene alluvial fan deposits (Qhf2) are located along the Coyote Creek channel and generally consist of clay, silt, sand, and gravel in the active creek channel. These materials are typically soft to medium stiff or loose to medium dense. Upper Pleistocene alluvial fan deposits (Qpf) are mapped predominantly in the southern and western portions of the study area, and are older, denser stream deposits that vary from clay to cobble size material. This alluvial material extends under the other younger basin and alluvial deposits in the valley, and as noted above, these deposits vary from about 200 feet thick at the northwest end of the Coyote Valley to about 400 feet thick at the southeast end of the study area.

Pliocene Silver Creek Gravel (Tsg). Pliocene Silver Creek gravels (Tsg) have been mapped underlying elevated terraces in the eastern portion of the site generally along the alignment of Highway 101. The Silver Creek gravels include interbedded conglomerate, sandstone, siltstone with minor tuffaceous sediment, tuff, and basalt. This formation is typically slightly cemented and friable and varies from thinly to thickly bedded.

Bedrock (fm, Jsp, fpv). The northern portion of the study area includes some highland areas that are underlain at relatively shallow depths by bedrock material. Wentworth, et al. (1999) and McLaughlin (2001) map bedrock in these areas as Franciscan mélange (fm), serpentinite (Jsp), and Franciscan basaltic volcanic rock (fpv) with occasional lenses of chert and silica carbonate rock. The character of bedrock materials in the region can vary substantially. Mélange and serpentinite can be highly sheared and sometimes contain clay gouge and abundant planes of geologic weakness. Blocks of sandstone within the Franciscan mélange and the silica carbonate rock are often moderately strong to strong with blocky fracturing.

Landslides (Qls)

Suspected landslides in the study have been shown on Preliminary Geologic Map using the mapping symbol "Qls." The suspected landslide areas generally appear to be surficial landslides that primarily involve soil but may include some highly weathered bedrock material. Most of the mapped landslides are considered dormant based on subdued topographic expression and vegetated scarps. Some areas of more recent landsliding were observed in the northwestern portion of the study area that have bare, near-vertical scarps and obviously hummocky slide deposits.

Expansive Soils

Some of the site soils, likely including those identified as existing fill, colluvium, alluvium, basin deposits and landslide debris are expected to be moderately to highly expansive. Expansive soils shrink and swell as a result of moisture changes. This can cause heaving and cracking of slabs-on-grade, pavements, and structures founded on shallow foundations. Successful construction on expansive soils requires special attention during grading and foundation designs that take the expansive soils into consideration.

Chrysotile Asbestos

Source areas for the basin and alluvial deposits in Coyote Valley contain areas underlain by serpentinite bedrock, which is a common bedrock material in northern California. Some serpentinite bedrock contains the mineral chrysotile, a naturally occurring form of asbestos. Chrysotile asbestos, however, is not found in all serpentine rock.

When chrysotile asbestos does occur, it is typically present in concentrations of less than 1 percent but may be present in concentrations up to about 10 percent. The chrysotile mineral can become airborne when the serpentine rock is crushed or pulverized. This can occur when vehicles travel over unpaved roads or driveways that are surfaced with serpentine bedrock materials, when land is graded for building purposes, or in quarrying operations. Only in this air-born form, is chrysotile asbestos considered a health risk.

Groundwater Conditions

Springs were observed in the southwest portion of Tulare Hill at the location noted on the Preliminary Geologic Map (Figure 2). Groundwater data from wells in the area compiled by Rogers and Williams (1974) indicates that the depth to groundwater increases in the Coyote

Valley from northwest to southeast. Groundwater levels in the northwest end of the valley are documented in the range of 5 to 15 feet below the ground surface, while the depth to groundwater in the southeast end of the valley is documented at roughly 50 to 90 feet below the ground surface.

It should be recognized that groundwater conditions may vary depending on factors such as groundwater withdrawal, weather conditions, time of year, changes in drainage patterns, and irrigation practices.

SEISMICITY AND SEISMIC HAZARDS

Regional Faulting

As with most of the Greater Bay Area, the site is situated within a seismically active region. The Calaveras fault is located about 3 miles to the northeast of the area while the Sargent and San Andreas faults are located approximately 6 miles and 9 miles, respectively, to the southwest (Bortugno, 1991). Each of these faults is considered a major active fault and has produced earthquakes within the last 200 years. The maximum earthquake for the region can be expected from the San Andreas fault, the major active fault within the Bay Area. Figures 5 and 6 of Appendix A show the site in relation to the faults in the region.

Site Faulting

The study area is not located within a State of California Earthquake Fault Hazard Zone for active faults (State of California, 1982). Portions of the study area, however, are located within City of San Jose Special Studies Zones and/or City of San Jose Potential Hazard Zones (1983) for the Coyote Creek fault and Shannon fault, as shown on Figure 2 of Appendix A. Additionally, an older geologic map by Cooper Clark (1974) shows a concealed and queried trace of the Shannon fault continuing across the central portion of the study area as shown on Figure 2.

Regional geologic mapping by McLaughlin, et al. (2001), Wentworth, et al. (1999), Cooper Clark (1974), and Dibblee (1973) show several faults and lineaments on the site. These mapped fault traces and lineaments have been shown on Figure 2 (Figure 3 of Appendix A) and numbered Fault/Lineament 1 through Fault/Lineament 12 for discussion purposes. Research, aerial photo interpretation, and site reconnaissance were unable to find evidence that suggested

Faults or Lineaments 2 through 8, 10, 11 and 12 are active or potentially active. Discussion about our findings and additional study for features labeled Fault 1 and Fault 9 follows.

Fault 1. Fault 1 is mapped by Wentworth (1999) in the northeastern portion of the study area within the vicinity of a Pacific Gas & Electric substation. This fault is mapped as "concealed" by older Holocene alluvial fan deposits (Qhf2). This fault is also mapped at the contact between serpentinite on the southwest and Silver Creek gravels on the northeast. A portion of this fault is located within the City of San Jose Potential Hazard Zone, and the fault appears to be associated with the Coyote Creek fault. At the time of our preliminary study, ENGEO did not observe clear geomorphic indications of Holocene activity during aerial photo interpretation or site reconnaissance; however, a topographic saddle feature is evident where the fault contact between the serpentinite and Silver Creek gravel is mapped. At this time, no development is proposed in the area of Fault 1; however, Fault 1 should be considered at least potentially active and would require a fault study if development is planned.

Fault 9. Fault 9 is mapped by McLaughlin (2001) and Wentworth (1999) in the northwestern portion of the study area. This fault is mapped as "concealed" under Holocene basin deposits by Wentworth (1999) and as "concealed" under Pleistocene alluvial fan deposits by McLaughlin (2001). This fault is also mapped at the contact between serpentinite and Franciscan Mélange, and McLaughlin (2001) indicates that this northwest-trending fault has experienced a relative upward sense of movement on the southwest side of the fault. Fault 9 is located within a City of San Jose Potential Hazard Zone, and the fault appears to be associated with the Shannon fault. A postulated southeast continuation of Fault 9 is shown on the Cooper Clark (1974) map as a concealed and queried trace of the Shannon fault crossing the Coyote Valley (Figure 2). Cooper Clark (1974) also shows a "Potentially Active Fault Zone" along this queried fault trace that is typically about 1,300 feet wide. Santa Clara County (2002) contains a similar mapped zone on their Geologic Hazards Zone map

Site mapping and aerial photo interpretation shows that the fault follows a relatively prominent linear valley trending to the northwest of the site. No geomorphic features were observed on aerial photographs examined during preliminary studies to support the Cooper Clark (1974) postulated projection of the Shannon fault crossing the Coyote Valley. Additional research included review of mapping by Roberts and Jachens (2003) and groundwater level maps compiled by Schaaf & Wheeler (2004), which are discussed in Appendix A.

Fault 9 was further studied by ENGEO (2006) and others (Lowney-Kaldveer Associates, 1974; Terratech, 1983; and Louke and Associates, 1983) within the northwestern one-third of the CVSP area, generally near and north of Bailey Road. Study by Lowney-Kaldveer Associates (LKA, 1974), which included trenching, borings, magnetometer survey, and seismic refraction, indicates evidence of the Shannon fault as shown on Figure 3 of Appendix A. This location is supported by the City of San Jose Potential Hazard Zone map (1983) and mapping by McLaughlin (2001). The LKA report states, however, that the age of the fault was not determined by soil dating. As a result, LKA (1974) concluded that the Shannon fault should be considered potentially active north of Bailey Road with a suggested habitable structure setback zone. Subsequent studies by Terratech (1983) and Louke and Associates (1983) found no indications of a significant through-going fault in the magnetic survey or in the seismic refraction survey, respectively, and no evidence of faulting across the Cooper Clark (1974) zone.

ENGEO (July 2006) performed six additional exploratory trenches and a series of test pits, ranging from 5 to 10 feet below the existing ground surface with some localized excavations to deeper depths to evaluate the soil or to follow stratigraphic units. The scope of services was coordinated with the City of San Jose Engineering Geologist, a third party reviewer for the City of San Jose, and an expert soil scientist to observe the trench walls for age-dating. Additionally, selected soil samples were collected and tested for carbon dating. The carbon dating indicated the alluvial soils exposed were dated to at least 8,400 (Holocene) and 13,000 years old (pre-Holocene). The results of soil stratigraphic study and carbon dating indicate that pre-Holocene soil or bedrock was encountered in the trenches, with exception of a short section of Trench ET-1 dated to be at least 8,400 years old.

Based on the findings of the limited fault exploration (Appendix A), no indications of Holocene-age, active faulting or seismic ground deformation were observed within the focus study area (northern Fault 9, Shannon fault) and the potential for ground rupture along this fault is considered unlikely. Additionally, no indications of faulting were encountered in the study area where a setback zone had been previously recommended by Lowney-Kaldveer Associates (1974). Lastly, although the short section of alluvial soil was not dated to be pre-Holocene (at least 11,000 years old), given the alluvial soil strata in question is at least 8,400 years old and does not exhibit indications of faulting, it is unlikely that an active fault exists in this section of the trench as well.

Historic Seismicity

Historic seismicity at CVSP was evaluated by reviewing Earthquakes and Faults in the San Francisco Bay Area (1970-2003) by Sleeter and others (2004). This map was generated by plotting epicenters for earthquakes greater than 1.5 Magnitude (Richter) using the earthquake data from the Northern California Earthquake Catalog. Recorded seismic events occur in two clusters along the Coyote Valley Fault. The northern cluster consists of approximately 20 seismic events east of Tulare Hill ranging from 1.5 to 5.0 Magnitude while the southern cluster, located north of Burnett Avenue consists of a seismic events ranging from 1.5 to 4.0 Magnitude. There are a few scattered seismic events recorded in the Coyote Valley ranging from 1.5 to 2.0 Magnitude. No seismic events were recorded along the Shannon Fault within the Coyote Valley.

Ground Shaking

As for other sites within the greater San Francisco Bay Area, the likelihood of at least one moderate to strong earthquake occurring during the life span of the project is considered high. The hazard of ground shaking on site can best be mitigated with construction that complies with applicable building codes. Seismic design provisions in current building codes generally prescribe minimum lateral forces applied statically to structures and combined with the gravity forces of dead-and-live loads.

Earthquake-Induced Liquefaction and Ground Failure

Liquefaction is a phenomenon in which saturated cohesionless soils are subject to a temporary loss of shear strength because of pore pressure build-up under the cyclic shear stresses associated with earthquakes. Rogers and Williams (1974) classify the northwestern portion of the study area as having a high potential for liquefaction, and the remainder of the study area as having low to moderate potential for liquefaction. This is supported by mapping prepared by the Association of Bay Area Governments (ABAG, 2001), which indicates that the potential for liquefaction at the site varies from low to very high. Figure 7 of ENGEO's 2004 study is a portion of the ABAG liquefaction susceptibility map showing the approximate limits of the study area for reference purposes. Maps prepared by Geomatrix (1992) indicate that the susceptibility to liquefaction is variable or unknown for most of the study area.

The State of California (2003) has also prepared Seismic Hazard Zone mapping covering the study areas located within the Santa Teresa Hills 7½-minute quadrangle and has produced a preliminary map for the Morgan Hill 7½-minute Quadrangle (2004). The portion of this mapping that covers the majority of the study area is shown on Figure 8 of ENGEO's 2004 study, and indicates most of the alluvial deposits in the Coyote Valley may be susceptible to liquefaction.

The publication by Youd and Hoose (1978) provides documentation of ground failures that were triggered by the 1906 San Francisco earthquake. Review of this publication described reported ground cracking and sand boils in the bottom of Coyote Creek near Metcalf Road.

Lurching, Lateral Spreading, and Seiches

Lurch cracking and lateral spreading can occur in weaker soils on slopes and adjacent to open channels that are subjected to strong ground shaking during earthquakes. Rogers and Williams (1974) classify the northern portion of the study area as having a high potential for lurching and lateral spreading. The potential for lurching and lateral spreading is generally mapped as low to moderate in the southern portion of the study area.

The potential for seiches at the CVSP study area is low to unlikely.

Earthquake-Induced Landsliding

Aerial photo interpretation and site reconnaissance observed the presence of potential perimeter landslides as mapped on Figure 2 (Figure 3 of the ENGEO 2004 report). The risk of slope instability is greater during major earthquakes than during other time periods. The State of California (2003 and 2004) has prepared Seismic Hazard Zone mapping for the Santa Teresa Hills and Morgan Hill 7½-minute quadrangles (Figure 8, ENGEO 2004). This mapping indicates that most of the hillside areas on the perimeter of the study area may be susceptible to seismically-induced landsliding.

Inundation from Reservoir Embankment Failure

The only known reservoir situated upstream of the study area is Anderson Lake, which is located about 2 miles to the south of the study area. Evaluation of the safety of Anderson Lake Dam is within the jurisdiction of the Federal Energy Regulatory Commission and California Division of Safety of Dams. The most recent FERC 5–year safety review of the dam was performed by GEI Consultants, Inc., dated December 2001. Review of the report indicates that the safety of the dam is considered acceptable by current standards. No improvements or upgrades to the dam are required based on the results of the GEI Consultants, Inc. report.

It should be noted that under extreme flooding or earthquake scenarios, failure of the dam is conceivable. Scenarios of this type are very unlikely, but it is our understanding that the potential for dam failure has been considered by local emergency service agencies.

GEOLOGY AND SEISMIC IMPACTS

Thresholds of Significance

For the purposes of the EIR, a geologic or seismic impact is considered significant if the project would:

- Expose people or structures to substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, strong seismic ground shaking, seismic-related ground failure (including liquefaction), landslides, or expansive soils.
- Expose people or property to major geologic hazards that cannot be mitigated through the use of standard engineering design and seismic safety techniques.
- Cause substantial erosion or siltation.

Soil Hazards

The primary soil and geologic hazards identified within the CVSP area are related to soft or compressible soils materials under foundation or planned fill loads; expansive soil materials when subjected to moisture fluctuations; presence of colluvial-filled swales on sloping terrain; potential for landsliding; potential for chrysotile asbestos; potential for creek bank erosion, scour or meander; and seasonally shallow groundwater levels.

- Construction of improvements (pavements, bridges, or foundations) or new fills on compressible near surface soils could cause structural damage. Design-level exploration and testing, with development of standard-of-practice remedial grading concepts and/or incorporation of appropriate soil criteria in foundation design can effectively address this hazard. **(Less than Significant Impact)**
- Construction of important facilities or moderate to heavy loaded structures (bridges, medium to high rise) on deeper compressible silt or clay layers could result in structural damage. Design/level exploration and development of ground improvement programs (such as

surcharge/wick drains) and/or incorporation of appropriate soil criteria in foundation design can effectively address this hazard. **(Less than Significant Impact)**

- Construction of improvements (pavements, bridges, or foundations) or new fills on moderately to highly expansive soil materials could result in structural damage. Design-level exploration and testing, with development of standard-of-practice remedial grading concepts and/or incorporation of appropriate soil criteria in foundation design can effectively address this hazard. **(Less than Significant Impact)**

- Planned cuts within colluvial filled swales (Qc) or landslides (Qls), construction within or in close proximity to these features could experience significant structural damage and slope instability. Design-level exploration and testing, slope stability analysis, and development of remedial grading concepts, including avoidance, buttressing, or reconstruction can address these hazards. **(Less than Significant Impact)**

- Existing site materials and those planned for import as engineered fills may be serpentinite derived and, therefore, may contain naturally-occurring chrysotile asbestos. Construction in and handling of chrysotile-asbestos materials will follow site-specific testing and development of specific work plans, as necessary, prepared and monitored by a qualified asbestos consultant under the requirements of the California Air Resource Board **(Less than Significant Impact)**

- Construction of planned improvements along existing or future natural-lined drainage channels could be impacted by bank erosion, scour or meander. Design-level exploration and lab testing, development of appropriate habitable and non-habitable structure setbacks, bank protection or revetment, design and construction of engineered systems (such as sheet piles, pin walls, etc) and/or remedial grading measures can effectively address these hazards. **(Less than Significant Impact)**

- Deep planned cuts or construction of subterranean facilities (parking or basement) in shallow groundwater may encounter groundwater and structure damage. Design-level exploration and testing, and development of recommendations for liners, temporary or permanent dewatering systems, and/or additional foundation design considerations due to hydrostatic pressures/uplift can address this hazard. **(Less than Significant Impact)**

<u>Seismic Hazards</u>

The primary seismic hazards identified within the CVSP area include strong ground shaking; soil deposits that may be susceptible to liquefaction, sand boils, densification and lateral spreading under seismic shaking conditions; the presence of potentially active faults in certain portions of the study area; and the potential for earthquake-induced slope instability (landsliding) in hillside areas adjacent to the study area. These potential hazards and other geotechnical issues relevant to the study area are discussed below.

- Development within the CVSP area results in planned improvements constructed in a region that is seismically active and subject to strong ground shaking. The hazard of ground shaking on site can best be mitigated with construction that complies with applicable building codes that presribe minimum lateral forces applied statically to structures and combined with the gravity forces of dead-and-live loads. **(Less than Significant Impact)**

- Development within the CVSP area results in planned improvements constructed on sites subject to seismic hazards, including earthquake-induced liquefaction, densification, sand boils, lateral spreading, and landsliding. Design-level exploration and testing, with development of either or a combination of standard-of-practice remedial grading concepts, ground improvement techniques, incorporating soil criteria in foundation design, or utilization of a specified foundation system (micropiles, deep foundation, mat foundation), depending upon conditions, can effectively address these hazards. **(Less than Significant Impact)**

- Development within active fault zones will sustain damage. Pre-development fault exploration within City or County mapped fault zones will be required and if active faulting is identified, appropriate structure setback for avoidance would be established and flexible joints and emergency shut off valves for utilities should be provided, as applicable. Additionally, special foundation design considerations may be required in areas adjacent to the fault setback zone. **(Significant Impact)**

- Development of high density residential, select and important facilities (schools, hospitals, fire departments, and police stations) and some bridges on potentially-active fault features may require special foundation design considerations or structure setbacks for avoidance. **(Less than Significant Impact)**

- Development of low to moderate density residential structures on potentially-active fault features may require incorporation of special foundation design considerations, or select foundation systems, such as a structural mat foundation, but may not require a structure setback for avoidance. **(Less than Significant Impact)**

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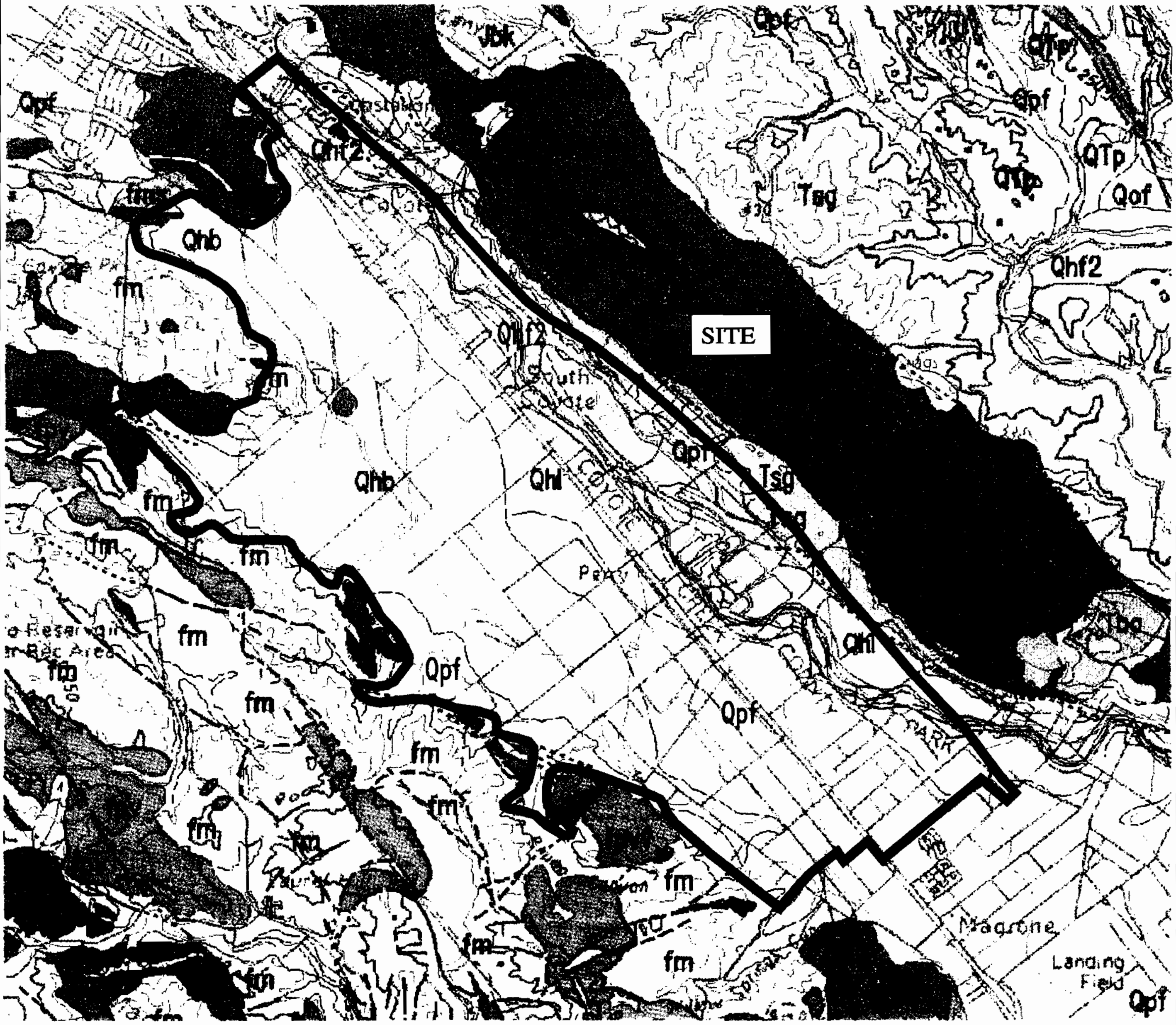
LIST OF FIGURES



EXPLANATION

- Qhb BASIN DEPOSITS
- Qhl LEVEE DEPOSITS
- Qhf2 OLDER ALLUVIUM FAN DEPOSITS
- Qpf ALLUVIAL FAN DEPOSITS
- Jsp SERPENTINIZED HARZBURGITE AND DUNITE
- Tsg SILVER CREEK GRAVELS
- fm MELANGE
- fpv BASALTIC VOLCANIC ROCKS
- fms GRAYWACKE

N

0 MILES 1
0 KILOMETERS 2

BASE MAP SOURCE: WENTWORTH, BLAKE, MCLAUGHLIN AND GRAYMER, 1999

ENGEO INCORPORATED EXCELLENT SERVICE SINCE 1971	REGIONAL GEOLOGY COYOTE VALLEY SPECIFIC PLAN AREA SAN JOSE, CALIFORNIA	PROJECT NO.: 5969.3.004.01 DATE: AUGUST 2006 DRAWN BY: SRP CHECKED BY: JAM	FIGURE NO. 1

ORIGINAL FIGURE PRINTED IN COLOR

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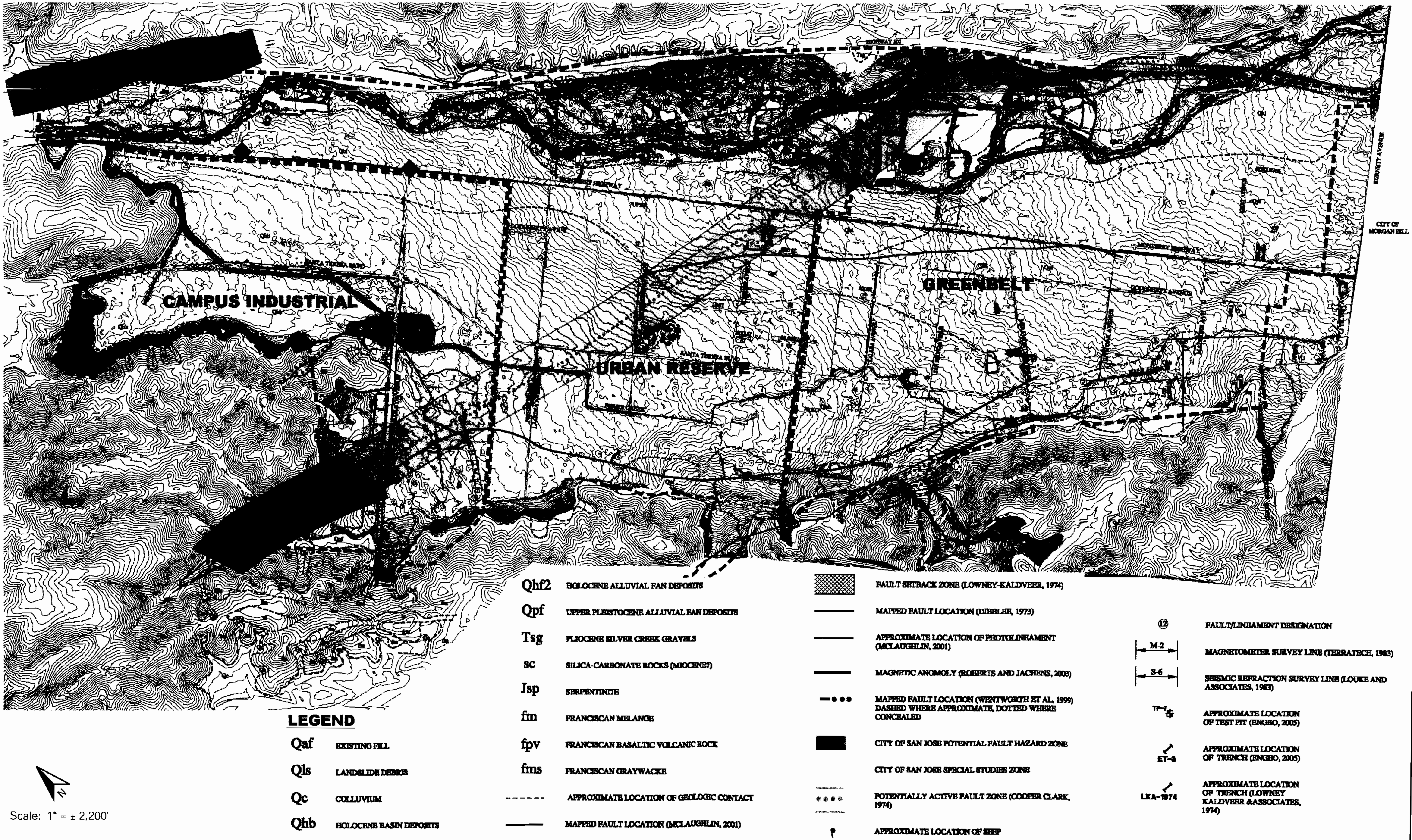

GEOLOGIC CONDITIONS MAP

FIGURE 2

APPENDIX A

ENGEO INCORPORATED

Limited Fault Exploration
July 2006

(SEE ATTACHED CD-ROM)

LIMITED FAULT EXPLORATION

COYOTE VALLEY SPECIFIC PLAN AREA

SAN JOSE, CALIFORNIA

SUBMITTED

TO

THE CITY OF SAN JOSE

SAN JOSE, CALIFORNIA

PREPARED

BY

ENGEO INCORPORATED

PROJECT NO. 5969.3.004.01

JULY 7, 2006

ENGEO
INCORPORATED

GEOTECHNICAL
ENVIRONMENTAL
WATER RESOURCES
CONSTRUCTION SERVICES

Project No.
5969.3.004.01

July 7, 2006

Mr. Darryl Boyd
Department of Planning, Building, and Code Enforcement
200 East Santa Clara Street
San Jose, CA 95113-1905

Subject: Coyote Valley Specific Plan Area
San Jose, California

LIMITED FAULT EXPLORATION

Dear Mr. Boyd:

We are pleased to submit our limited fault exploration for evaluation of potential fault hazards for the Coyote Valley Specific Plan (CVSP) area in San Jose, California. This report is based upon the scope of service provided in our proposal revised August 2, 2005, and in coordination with the geotechnical services during preparation of the environmental impact report (EIR) for the CVSP.

Based on the findings of our fault evaluation, no indications of active faulting or fault related ground deformation were found within the study area. In our opinion, it is reasonable to proceed with planning in the CVSP area without the need for setbacks from the previously mapped projection of the Shannon fault. Further studies and exploration will be required to develop site specific design and construction recommendations.

We are pleased to have been of service on this project and are prepared to consult further with you and your design team as planning progresses. If you have any questions regarding the contents of this report, please do not hesitate to contact us.

Very truly yours,

ENGEO INCORPORATED

Kelsey Adams

Anthony A. Schuetze

Julia A. Moriarty, GE

aas/smc: fault exploration

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No. 1239
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

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Letter of Transmittal

5969.3.004.01
July 7, 2006

INTRODUCTION

Purpose and Scope

The purpose of this exploration has been to evaluate potential fault hazards in the Coyote Valley Specific Plan (CVSP) area, by focusing on the northwest portion of the site. The information developed from our study is intended to assist in the project-specific Environmental Impact Report (EIR) process and will also be used as a resource for land planning of the CVSP mixed-use community.

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Site Location and Description

The focus study area, which is part of the roughly 7,000-acre study area known as Coyote Valley and shown on the attached Vicinity Map (Figures 1 and 2), is bordered by Bailey Avenue on the south, IBM business complex to the east, and undeveloped land to the north and west (Figure 3). The roughly rectangular shaped study area comprises the Potential Fault Hazard Zone established by City of San Jose (1983) which is roughly 0.8 miles long and about 0.3 miles wide and approximately 145 acres in size. The topography in the study area is a portion of a roughly northwest-southeast oriented wide, relatively flat valley that narrows to the northwest.

The valley floor in the study area drains to the southeast, with Elevations ranging from approximately 350 feet above mean sea level (msl) in the northwest corner to 260 feet above msl at Bailey Avenue. Seasonal drainage channels transport surface water from upland/upgradient areas across the valley and ultimately into Coyote Creek, which is located between Highway 101 and Monterey Highway.

The focus study area consists of four Assessor's Parcel Numbers (APN). Two parcels (APN 708-31-004 and 708-32-006) are owned by IBM, one parcel (APN 708-32-004) is owned by the Holthouse Trust, and one parcel (APN 708-32-003) is owned by PG&E. The land is undeveloped pasture land with the exception of one barn-like structure used for agriculture in the middle of the eastern portion of the study area. The study area has experienced a wide variety of previous usage, although mostly agricultural, including at least orchards and crop farming.

Proposed Development

As directed by the San Jose 2002 General Plan, the Specific Plan for Coyote Valley (CVSP) will consist of the Urban Reserve to the north and Coyote Greenbelt to the south of the greater 7,000 acre site. The Urban Reserve will be the focus area of development, with the Coyote Greenbelt identified as a non-urban buffer between the cities of San Jose and Morgan Hill.

GEOLOGIC CONDITIONS

Geologic Setting

The study area is located in the Coast Ranges geomorphic province of California. The Coast Ranges are dominated by a series of northwest-trending ridges and valleys that have been formed by faulting and folding of the earth's crust. A published geologic map of the vicinity (Wentworth et al., 1999) indicates that the Coyote Valley is underlain by basin deposits and alluvial deposits ranging from Pliocene to Holocene age (about 5 million years old to recent time). Studies by Rogers and Williams (1974) indicate that these sedimentary deposits vary from about 200 feet thick at the northwestern end of the Coyote Valley to more than 400 feet thick in the southeastern end of the Valley.

Upper Pleistocene alluvial fan deposits (Qpf) are mapped predominantly in the valley portions of the focus study area north of Bailey Road. These deposits are older, denser stream deposits that vary from clay to cobble size material.

The ridges above the valley floor portion of the study area are mapped as underlain by relatively shallow bedrock material. Wentworth, et al. (1999) and McLaughlin (2001) map bedrock in these areas as serpentinite (Jsp), and Franciscan basaltic volcanic rock (fpv) with occasional lenses of chert and silica carbonate rock. The character of bedrock materials in the region can vary substantially. Serpentinite can be highly sheared and sometimes contain clay gouge and abundant planes of geologic weakness. Blocks of sandstone within the Franciscan mélange and the silica carbonate rock are often moderately strong to strong with blocky fracturing. Contacts between the various rock types are typically fault contacts but are generally not associated with the currently active fault systems in the Bay Area.

Published Fault Mapping

The study area is not located within a State of California Earthquake Fault Hazard Zone for active faults (State of California, 1982) but is located within City of San Jose Potential Fault Hazard Zone for the Shannon fault (1983), as shown on Figures 2 and 3. Also shown on Figure 3 is older geologic mapping by Cooper Clark (1974) consisting of a concealed and queried trace of the Shannon fault, with an associated fault study zone, continuing across the central portion of the greater CVSP area.

Regional geologic mapping by McLaughlin, et al. (2001), Wentworth, et al. (1999), Cooper Clark (1974), and Dibblee (1973) show faults and lineaments on the site. These mapped fault traces and lineaments have been shown on Figure 3 as Fault 9. Below is a discussion of reported faulting through the greater CVSP study area. Additional discussion of entire regional faulting and seismicity through the CVSP can be found in previous report prepared by ENGEO (2004) titled "Preliminary Geotechnical Evaluation, Coyote Valley Specific Plan, San Jose, California" and referenced in the Select References.

Fault 9 is mapped by McLaughlin (2001), Dibblee (1973) and Wentworth (1999) and trended in a northwest-southeast orientation through the valley floor of the study area (Figure 3). This fault is mapped as "concealed" under Holocene basin deposits by Wentworth (1999) and as "concealed" under Pleistocene alluvial fan deposits by McLaughlin (2001). This fault is also mapped at the contact between serpentinite and Franciscan Mélange and McLaughlin (2001) indicates that this northwest-trending fault has experienced a relative upward sense of movement on the southwest side of the fault. As shown on Figure 3, Fault 9 is located within a City of San Jose Potential Fault Hazard Zone (1983) and appears to be associated with the Shannon fault.

A postulated southeast continuation of Fault 9, discussed above, is shown on the Cooper Clark (1974) map as a concealed and queried trace of the Shannon fault crossing the Coyote Valley (Figure 3). Cooper Clark (1974) also shows a "Potentially Active Fault Zone" along this queried fault trace that is typically 1,300 feet wide.

Additional Shannon fault research included review of mapping by Roberts and Jachens (2003). Roberts and Jachens (2003) prepared a shaded relief aeromagnetic map of the Santa Clara Valley. The map includes lineations that represent the probable edges of magnetic bodies. A lineation of this type is mapped roughly parallel with the portion of the Shannon fault mapped within our focus study area of the greater CVSP site. As the magnetic lineation extends south of Bailey Road into Coyote Valley, the lineation bends to the south and becomes roughly parallel with the west margin of the valley as shown on Figure 3. Two magnetic lineations in the eastern portion of the study area trend roughly parallel to Highway 101 and appear to cut across the projection of the Shannon fault. This mapping of magnetic data suggests that the Shannon fault may not follow the postulated projection of the Shannon fault across the Coyote Valley that was mapped by Cooper Clark (1974).

Prior Shannon Fault Studies

Several Shannon Fault studies were previously performed within the CVSP area just north and south of Bailey Road and reviewed by ENGEO as a part of our research. Those studies, along with their findings, are briefly discussed below.

Terratech (1983). A previous Shannon Fault study was performed on a property, situated in the northwest portion of CVSP and just south of Bailey Road, by Terratech (1983). This study was undertaken to evaluate the Cooper Clark (1974) postulated projection of the Shannon fault. The study by Terratech (1983) included two magnetometer survey lines totaling roughly 6,100 lineal feet. The approximate locations of the magnetometer survey lines (M-1 and M-2) are shown on

Figure 3. The report indicated that one magnetic anomaly was in proximity to the projected alignment of the Shannon fault; however, no similar anomaly was found in a parallel magnetic survey line located to the northwest to support the anomaly. Although magnetic anomalies can be caused by many different subsurface conditions, a significant through-going fault would be expected to cause magnetic anomalies in each survey line that crosses the fault. However, no indications of a significant through-going fault were found in the Terratech (1983) magnetic survey.

Louke and Associates (1983). To further evaluate the possibility for projection of the Shannon fault across the property documented in the Terratech (1983) report discussed above, a seismic refraction survey was performed by Louke and Associates (1983) and included as an attachment to the Terratech (1983) study. A series of overlapping seismic refraction survey lines (S-1 through S-6) were performed across the Cooper Clark (1974) projection of the Shannon fault as shown on Figure 3. The survey lines were each about 600 feet long and, according to the data presented by Louke and Associates, it was possible to interpret the depth and seismic velocities of the bedrock materials underlying the valley alluvium. Louke and Associates (1983) concluded that no evidence of faulting across the Cooper Clark (1974) zone was identified in the seismic refraction survey.

Lowney-Kaldveer Associates (1974). An earlier Shannon fault exploration was performed by Lowney-Kaldveer Associates (LKA) in 1974 for the existing IBM site located on the north side of Bailey Avenue. The study by LKA included four exploratory trenches, two exploratory borings, six magnetometer survey lines and seven seismic refraction survey lines. We were not able to obtain a map showing the locations of the trenches, borings and geophysical survey lines; however, we believe that the explorations occurred within the existing IBM study site, thus north of Bailey Avenue in the assumed general vicinity of the Cooper Clark (1974) Potentially Active Fault Zone. Conditions described in the exploration logs and the text of the report are summarized below:

Test Trench 1 – The text of the report indicates that Trench 1 was excavated across the assumed trace of the Shannon fault in an area that is underlain by alluvium. A 4-inch-thick layer of clay with some organic matter was mapped over sandy clay with some gravel. The trench was about 50 feet long and 7 feet deep and the log indicates that no indication of faulting was encountered.

Test Trench 2 – The text of the report indicates that Trench 2 was excavated "about 300 feet north of the assumed trace of the Shannon fault in an area of unusual topography near the location where the fault emerges from the hills and enters the alluvium". A zone of sheared serpentinite, roughly 20 wide was encountered. Blocky serpentinite was encountered on both the north and south ends of the trench. Fill roughly 2 to 3 feet thick was found overlying the shear zone and alluvium was mapped over serpentinite in the southern portion of the trench. LKA concluded that the shear zone encountered in this trench was likely an ancient shear zone and not a significant seismic feature.

Test Trench 3 – Similar to Trench 2, the text of the report indicates that Trench 3 was excavated about 300 feet north of the assumed trace of the Shannon fault. The trench exposed clayey sand soil roughly 1 to 2 feet thick over sandstone and serpentinite rock. A zone of sheared serpentinite was mapped between blocky sandstone on the south and serpentinite on the north. The orientation of the sheared contact was not provided in the log. No shearing or other features that could be associated with faulting were mapped in the soil layer overlying the shear zone. LKA concluded that the shear zone encountered in this trench was likely an ancient shear zone and not a significant seismic feature.

Test Trench 4 – The text of the report indicates that Trench 4 was excavated across the assumed trace of the Shannon fault, apparently to the northwest of Trench 1 where soil deposits were relatively thin. An organic silt soil was exposed in Trench 4 that was roughly 2 to 3 feet thick. Underlying the soil, a shear zone about 30 feet wide was encountered. The sheared zone was mapped at the contact between siliceous sandstone on the south and serpentinite on the north. An inclusion of silica carbonate rock was noted within the shear zone and the shear zone was described as the probable location of the Shannon fault. No shearing or other features that could be indicative of faulting were mapped in the soil layer overlying the shear zone and the orientation of the shear zone was not provided in the log.

Boring 1 and Boring 2 – The text of the report indicates that Boring 1 and Boring 2 were drilled on either side of the assumed trace of the Shannon fault. Both borings encountered stiff clay to a depth of about 13 feet, underlain by dense to very dense silt, sand and clay. In Boring 1, shale was encountered at a depth of 61 feet and in Boring 2, shale was encountered at a depth of 56 feet, indicating roughly a 5-foot vertical offset in bedrock. The LKA report states that groundwater levels measured on March 20, 1974, were 5.5 feet below the ground surface in both borings.

Magnetometer Survey – Survey data in the LKA report indicates that magnetic anomalies were found in Survey Lines 1, 2, 3 and 4 and that these anomalies most likely indicate the presence of the Shannon fault.

Seismic Refraction Survey – Survey data notes that anomalies were found in the seismic refraction survey and that these anomalies most likely indicate the presence of the Shannon fault. As noted above, the map showing the locations of these survey line and anomalies has not been made available for our review; however, we believe that exploration locations are located north of Bailey Avenue.

Based on the findings of their exploration, Lowney-Kaldveer Associates (1974) mapped the Shannon fault across the IBM site as shown on Figure 3 immediately north of Bailey Road, which is located within the City of San Jose Potential Fault Hazard Zone (1983). The report states that the age of the fault was not determined but they concluded that the Shannon fault should be considered potentially active across the subject IBM site. Lowney-Kaldveer Associates recommended that structures be set back at least 50 feet from the fault zone they mapped (Figure 3).

Groundwater

Groundwater data from wells in the area compiled by Rogers and Williams (1974) indicates that the depth to groundwater increases in the CVSP from northwest to southeast. Groundwater levels in the study area are documented in the range of 5 to 15 feet below the ground surface.

Groundwater level maps in the Coyote Valley, compiled by Schaaf & Wheeler (2004), were reviewed by ENGEO as a part of faulting research. Groundwater level anomalies are common within fault zones since faulting creates discontinuities in subsurface stratigraphy; therefore, discontinuity in groundwater paths or development of ground water barriers. No clear indication of groundwater level anomalies were noted on the groundwater map along the Cooper Clark (1974) postulated projection of the Shannon fault across the Coyote Valley. Based upon groundwater levels reviewed, undulations in the groundwater level contours generally follow trends that are parallel to the long axis of the Coyote Valley.

It should be recognized that groundwater conditions may vary depending on factors such as groundwater withdrawal, weather conditions, time of year, changes in drainage patterns, and irrigation practices. Groundwater was encountered at 21 feet below the ground surface during this fault exploration along the northern boundary near the center of the site at exploration trench ET-1. Groundwater was not encountered in the other exploratory trenches or test pits.

Seismicity

As noted earlier, regional geologic mapping by McLaughlin, et al. (2001), Wentworth, et al. (1999), Cooper Clark (1974), and Dibblee (1973) show several faults and lineaments on the site. These mapped fault traces and lineaments have been shown on Figure 3 and discussed in detail in our prior document (ENGEO, 2004). Two areas within the CVSP are considered Potential Fault Hazard Zones and one area considered a Special Studies Zone by the City of San Jose (1983) due to the mapped fault traces. These areas are the northwest corner of the site due to the mapped presence of the Shannon fault and the northeast corner of the site due to the mapped presence of the Coyote Valley fault. As with most of the Greater Bay Area, the site is situated within a seismically active region. Figure 4 shows the site in relation to the faults in the region.

Site historic seismicity was evaluated by reviewing Earthquakes and Faults in the San Francisco Bay Area (1970-2003) by Sleeter and others (2004). This map was generated by plotting epicenters for earthquakes greater than 1.5 Magnitude (Richter) using the earthquake data from the Northern California Earthquake Catalog. Figure 5 shows the portion of this map that includes CVSP. Recorded seismic events occur in two clusters along then Coyote Valley fault. The northern cluster consists of approximately 20 seismic events east of Tulare Hill ranging from 1.5 to 5.0 Magnitude while the southern cluster, located north of Burnett Avenue consists of a seismic events ranging from 1.5 to 4.0 Magnitude. There are a few scattered seismic events recorded in the Coyote Valley ranging from 1.5 to 2.0 Magnitude. No seismic events are recorded along the Shannon fault within the Coyote Valley or for a distance of about 1/2 mile extending to the northwest of the study area.

Lowney-Kaldveer Associates (1974) report that review of 1969 and 1970 active faults and preliminary earthquake epicenters show some activity exists along the Shannon fault farther north from the study area near Los Gatos; however, no seismic events through this period are plotted within their study area.

Geomorphology

Site mapping and aerial photograph interpretation indicate that the Shannon fault generally follows a relatively prominent linear valley trending to the northwest of the focus study area. The linear hill front along the east side of the study area observed on aerial photographs (Figure 6) is roughly parallel to the mapped trace of the mapped alignment of the Shannon Fault and consistent with the Cooper Clark (1974) postulated projection of the Shannon fault crossing the Coyote Valley. The hill front along the west side of the study area is aligned in a more northerly orientation than the mapped alignment of the Shannon fault.

A topographic saddle was also observed in the hillside area on the west side of the study area, near the magnetic anomaly mapped by Roberts and Jachens (2003) and as shown on Figure 3, this magnetic anomaly trends toward exploratory Trench ET-3.

FIELD EXPLORATION

To further address the activity of the Shannon fault within the focus study area and the greater CVSP area, six exploratory trenches with cumulative lengths totaling approximately 875 (±) lineal feet, and seven test pits were excavated under the observation of ENGEO geologists in October 2005 at the locations shown on Figures 3 and 6.

The trenches and test pits were located in the field by taping and pacing from topographic features shown on the topographic base map for the project; therefore, should be considered accurately located only to the degree implied by the method used. At the completion of the field service, the excavations were loosely backfilled using a track-mounted excavator and slightly mounded with soil to hinder ponding of storm water.

A representative of Lowney Associates, 3rd party reviewer for the City of San Jose, was on-site at the beginning of the operation to review trench excavations. The reviewer was kept informed of significant findings during fault the remainder of the trench explorations.

Exploratory Trench Excavations

As noted above, six exploratory trenches were excavated as part of the fault study. Trench logs prepared for this study are presented on Figures 7 through 10, with locations of trenches shown on Figures 3 and 6.

The trenches typically ranged in depth from 5 to 10 feet below the existing ground surface, with some potholes extended through the base of the trench to evaluate soil or follow stratigraphic units. The southerly wall of each trench was cleaned with hand tools and mapped by ENGEO geologists. The exposure was logged at horizontal and vertical scales of 1 inch to 5 feet. A summary of the trench excavation findings is discussed in the subsequent paragraphs.

Trench ET-1. Trench ET-1 was excavated trending from N5°E along the eastern side of the focus study area (Figure 3 and 6). The trench started northeast of an existing dirt access road and drainage channel and extended across agriculture land and was ended on the south side of the IBM loop access road. This trench was excavated across the fault setback zone that was previously recommended by Lowney-Kaldveer Associates in 1974.

As shown in Figure 8, the upper soil horizon consisted of regularly tilled soil and ranged from about 1 to 2 feet thick along the entire length of the trench. This unit is generally characterized as silty clay with trace sand, gravel and rootlets. Alluvium was encountered underlying the upper soil, consisting of silty clay with sand, gravel and rootlets. Gravel consists of reddish and yellowish-brown sandstone, siltstone and serpentinite clasts and ranged from sub-rounded to angular. Abundant charcoal fragments ranging from ¼ to ¾ inch diameter were observed throughout the entire thickness of the alluvial unit. Charcoal samples were collected near the base of the trench to help date this unit; soil age determinations are discussed in a subsequent section of this report.

Two alluvial channel features were encountered from approximately Stations 0+80 to 1+10 and 1+40 to the north end of the trench. These channel features ranged up to about 5 feet thick and consisted of sand, sandy gravel and gravel deposits. These units consist of well sorted fine to coarse sand and gravels up to 4 inches in diameter consisting of sub-rounded siltstone, metasedimentary and serpentinite clasts.

Older alluvium was encountered from the southern end of the trench (Station 0+00) to approximately Station 1+05 beneath younger alluvium and channel fill with a non-continuous paleosol surface at the top of the unit. This unit was generally flat lying and thinning to the north. A section of the exploratory trench was deepened an additional 5 feet to a depth of approximately 13 feet at Station 1+00. The older alluvium was observed extending to the base of the excavation with the contact dipping to the north. A silty clay unit was encountered from approximately Station 1+40 to the north end of the trench below the channel deposit. This unit was a highly weathered or reworked siltstone and characterized by smooth undulating ped surfaces due to shrink/swell.

Beneath the highly weathered siltstone, a very friable, moderately weathered siltstone unit was encountered from approximately Station 1+45 to the north end of the trench. The trench was deepened to approximately 21 feet from approximately Station 1+40 to the north end of the trench in an attempt to follow the bedrock unit which dipped off steeply to the south. Beneath the siltstone unit a foliated, moderately weathered serpentinite unit was encountered between approximately Station 1+55 and 1+62. Groundwater was encountered at 21 feet below the ground surface during exploration. No shears, clay gouge or other indications of seismic deformation were observed within Trench ET-1.

Trench ET-1A. Trench ET-1A was excavated approximately 400 feet north, and upslope, from ET-1 along the north side of the IBM loop access road along the east edge of the focus study area (Figures 3 and 6). Trench ET-1A trended N5°E and was started approximately one-third up the slope where serpentinite outcrops were observed at the surface.

As shown on Figure 7, the upper soil horizon consisted of colluvial soil that ranged from about 0 to 2 feet thick along the entire length of the trench, thickening in the southern one-third of the trench where the slope shallows/flattens. This unit is generally characterized as silty clay with trace sand, gravel and rootlets. Gravel generally consists of siltstone and serpentinite clasts and ranged from sub-rounded to angular.

Beneath this soil unit serpentinite bedrock was encountered from the north end of the trench to approximately Station 0+15 and characterized by moderately to highly weathered, internally sheared with some resistant blocks and ranges from foliated to blocky. Siltstone was encountered from approximately Station 0+15 to the south end of the trench. This unit is moderately weathered and ranges from blocky and fractured to bedded, with bedding generally dipping upslope to the north. The contact between serpentinite and siltstone at approximately Station 0+15 consisted of a shear plane in the west wall with some parting oriented N86°E-56°NW and a subtle shear surface in the east wall oriented N82°E-22°NW. The orientation of this feature is nearly perpendicular to the mapped northwest trending Shannon fault. This feature did not extend into or offset the upper soil unit and is considered to be an older fault contact within the Franciscan bedrock.

Trench ET-2. Trench ET-2 was excavated just north of the IBM loop access road along the northeast edge of the focus study area. Trench ET-2 trended S20°E and was started approximately at the slope break where serpentinite outcropping was observed at the surface (approximately 75 feet north of the IBM loop access road) and ended approximately 10 feet upslope from the fence along the north side of the IBM loop access road. This trench was situated where undulations in the topography suggested the location of one of the previous trenches by Lowney-Kaldveer Associates (1974). Distance measurements noted above are along the existing terrain.

The upper soil horizon consisted of colluvial soil and ranged from about ½ to 2 feet thick along the entire length of the trench, thickening in the southern portion of the trench where the slope shallows/flattens (Figure 7). This unit is generally characterized as silty clay with trace sand, gravel and rootlets, with gravel consisting of serpentinite fragments. A loose area up to 5 feet thick and 5 feet wide was encountered at approximately Station 0+10 and consisted of serpentinite fragments and soil voids. This might represent a previously excavated fault exploration trench oriented in a roughly east-west orientation.

Beneath this soil unit serpentinite bedrock was encountered along the entire length of the trench and characterized as moderately to highly weathered, internally sheared with some resistant blocks and ranges from variable foliations to blocky.

No indications of neo-tectonic seismic deformation were observed within Trench ET-2.

Trench ET-3. Trench ET-3 was excavated just west of the IBM loop access road along the western edge of the study area (Figures 3 and 6). Trench ET-3 trended N75°E and was started approximately 140 feet west of the IBM loop access road and ended approximately 10 feet upslope from the fence along the west side of the IBM loop access road. The trench did not extend through the fence or the access road and was continued just below the access road trending N50°E, ending approximately 160 feet beyond the access road just past the break in slope. The intent of this trench was to evaluate the contact between serpentinite rocks observed in outcrops upslope of the IBM loop access road and Franciscan claystone rocks observed in road cuts along the loop access road. Distance measurements noted above are along the existing terrain.

The upper soil horizon consisted of colluvial soil and ranged from about 1 to 2.5 feet thick along the length of the trench above the road (Figure 9). This unit is generally characterized as silty clay with trace sand, gravel and rootlets, with gravel consisting of serpentinite and siltstone fragments. At the base of this unit a stiff clay shear surface was observed at multiple locations along the length of the trench above the road. This discontinuous shear surface was characterized by an undulatory surface with clay parting and slickensides trending roughly parallel to the ground surface. This feature appears to be the result of soil creep. A small wedge of road fill was observed in the upper zone of the continued trench at approximately Station 1+60 just east of the IBM loop access road. The upper soil horizon east of this road fill wedge began at approximately Station 1+63 and consisted of weathered bedrock characterized by silty clay with siltstone rock fragments. The upper zone transitioned from weathered bedrock to a soil zone at the break in slope at approximately Station 2+40. The upper soil horizon consisted of regularly tilled soil and ranged from about 1 to 2 feet thick to the eastern end of the trench. This unit is generally characterized as silty clay with trace sand, gravel and rootlets. Underlying this unit, beginning at approximately Station 2+62 to the eastern end of the trench, alluvium was encountered consisting of silty clay with sand, gravel and rootlets. Gravel consists of reddish and yellowish-brown sandstone, siltstone and serpentinite clasts and ranged from sub-rounded to angular. Abundant charcoal fragments up to ½ inch in diameter were observed throughout the thickness of this unit. Beneath this unit a channel deposit was encountered at approximately Station 2+95 that extended to the eastern end of the trench. This unit consists of well-sorted fine to coarse sand, and gravels up to 2 inches in diameter consisting of sub-rounded siltstone, metasedimentary, siltstone and serpentinite clasts.

Beneath these soil units, bedrock was encountered along the entire length of the trench. Serpentinite bedrock was encountered from the west end of the trench to approximately Station 0+50 and characterized as moderately to highly weathered, internally sheared with carbonate and talc zones and ranges from heavily foliated and weak to blocky and dense. Some resistant blocks of serpentinite and metasedimentary rocks were observed within a sheared and weak matrix. Siltstone, shale and sandstone were encountered from approximately Station 0+50 to 2+20, with inter-tonguing depositional contacts. This unit is moderately weathered and ranges from blocky and fractured to bedded, with occasional serpentinite blocks and fragments observed. Serpentinite bedrock was encountered from approximately Station 2+20 to the east end of the trench and characterized as moderately to highly weathered, internally sheared and ranges from heavily foliated and weak to blocky and dense. Some resistant blocks of serpentinite were observed within a sheared and weak matrix. Some wedges of soil fill were observed in fractures in bedrock.

Two carbonate zones at approximately Stations 0+40 and 0+50 were observed to extend through serpentinite and approximately 6 inches into overlying soil unit. The carbonate zones range from

3 to 6 inches thick with dips flattening down slope within the soil unit. No shear plane or offset beds were observed within bedrock or soil units suggesting these carbonate zones may be a relic feature left behind from weathering of the bedrock.

Trench ET-3A. Trench ET-3A was excavated approximately 25 feet south of ET-3 along strike with two carbonate zone features observed and trended N88°E (Figures 3 and 6). The carbonate zones were projected between Trenches ET-3 and ET-3A at a trend of approximately N10°E.

The upper soil horizon consisted of colluvial soil and ranged from about 1.5 to 2.5 feet thick along the length of the trench (Figure 7). This unit is generally characterized as silty clay with trace sand, gravel and rootlets, with gravel consisting of serpentinite fragments. At the base of this unit a stiff clay shear surface was observed at multiple locations along the length. This discontinuous shear surface was characterized by an undulatory surface with clay partings. This feature appears to be the result of soil creep and not a fault related feature. Beneath this soil unit bedrock was encountered along the entire length of the trench. Serpentinite bedrock was encountered from the west end of the trench to approximately Station 0+15 and characterized as moderately weathered, internally sheared and ranges from foliated to blocky. Siltstone was encountered from approximately Station 0+15 to the east end of the trench. This unit is moderately weathered and generally blocky and fractured.

Two carbonate zones at approximately Stations 0+10 and 0+12 were observed, with carbonate zone at Station 0+10 extending through serpentinite and approximately 6 inches into overlying soil unit. The carbonate zones range from 3 to 6 inches thick with dips flattening down slope within the soil unit. No shear plane or offset beds were observed within bedrock or soil units suggesting these carbonate zones are a relic feature left behind from weathering

Trench ET-4. Trench ET-4 was excavated in the northwest corner of the project approximately 50 feet below the small reservoir (Figures 3 and 6). Trench ET-4 trended S25°E and was started approximately 5 feet below an existing fence just above the break in slope on the north side of the valley where serpentinite was observed to be cropping out at the slope surface and ended in the north edge of the berm approximately 10 feet north of the drainage on the south side of the valley. Serpentinite was observed to be cropping out in the drainage on the south side of the valley. The purpose of this trench was to explore across the full width of the valley where the character of the valley makes a geomorphic transition. Northwest of trench location ET-4 the valley is relatively narrow and steep sided. Southeast of trench location ET-4 the floor of the valley becomes broad and flat and valley side slopes vary from gentle to steep. Distance measurements noted above are along the existing terrain.

As depicted on Figure 10, the upper soil horizon consisted of regularly tilled soil and ranged from about 1.5 to 3 feet thick along the entire length of the trench. This unit is generally characterized as silty clay with trace sand, gravel and rootlets. Artificial fill for the existing berm was encountered at the southern end of the trench along the north side of the drainage course. Beneath this upper soil horizon, alluvium was encountered consisting of silty clay with sand, gravel and rootlets. Gravel consists of reddish and yellowish-brown sandstone, siltstone and serpentinite clasts and ranged from sub-rounded to angular. Abundant charcoal fragments ranging from ¼ to ½ inch diameter were observed throughout the thickness of this unit. One sample (Sample C-5) was collected near the base of the trench to help date this unit. AMS C^{14} age determinations of charcoal sampled collected is reported in a subsequent section of this document.

A channel deposit was encountered along the trench averaging 3 feet thick but up to 5 feet thick consisting of sand, sandy gravel and gravel deposits between approximately Stations 0+45 and 0+80. This unit consists of well-sorted fine to coarse sand and gravels up to 9 inches in diameter consisting of sub-rounded siltstone, metasedimentary and serpentinite clasts. The topography slopes upward 3 feet at approximately Station 2+00 southward to the drainage. The upper soil zones appear to be consistent thickness so this increase in slope might be the result of a fan deposit from the drainage along the northwest corner of the valley.

Beneath these soil units serpentinite bedrock was encountered from the northeast end of the trench to approximately Station 0+45 and characterized as moderately to highly weathered, internally sheared with carbonate and talc zones and ranges from heavily foliated and weak to blocky and dense. Some resistant blocks of serpentinite were observed within a sheared and weak matrix. A silty clay unit was encountered from approximately Station 2+65 to the southwest end of the trench. This unit was a highly weathered or reworked siltstone and characterized by smooth undulating ped surfaces due to shrink/swell. Beneath this highly weathered siltstone unit a blocky, poorly bedded, moderately weathered siltstone unit was encountered from approximately Station 2+70 to the south end of the trench. The trench was deepened to approximately 16 feet from approximately Station 2+65 to the south end of the trench. No shears or other indications of seismic deformation were observed within Trench ET-4.

Test Pit Excavation

In addition to the exploratory trenches, seven exploratory test pits were excavated in October 2005 at the locations shown on Figure 6. These exploratory test pits were used to locate bedrock contacts within the Franciscan bedrock and to determine exploratory trenching sites. The test pit locations shown on Figure 6 were located in the field by pacing from cultural features on the topographic map; therefore, should be considered accurately located only to the degree implied by the method used.

The test pits typically ranged from 3 to 21 feet below the existing ground surface. Test pits and were logged by ENGEO geologists. The logs of test pits are presented in Appendix A.

Pedochronology and Carbon Dating

To assist in the evaluation of the age of the paleosols encountered, Mr. Glenn Borchardt of Soil Tectonics was retained to evaluate the soil stratigraphy in Trench ET-1. According to the assessment provided by Soil Tectonics, the thickness of the Bt horizons and other characteristics indicate that the Bt horizon in the southern end of Trench ET-1 probably started to form about 13,000 calendar years ago, prior to the Holocene-Pleistocene transition at 10,000 calendar years ago (10 ka). The results of the assessment are included in Appendix B.

To further assess the age of the soils encountered in the trenches, two charcoal samples (Sample C-2 and C-3) collected by ENGEO in Trench ET-1 and one charcoal sample (Sample C-5) collected by ENGEO in Trench ET-4 were submitted for age determination to correlate the age of units encountered and confirm the above reported age estimates by the soil scientist. Age determination of these samples was performed in January 2006 using accelerator mass spectrometry (AMS) Carbon-14 (C^{14}) by Geochron Laboratories in Cambridge, Massachusetts. Reported AMS results are included in Appendix B. Calibration of these reported dates implemented Radiocarbon Calibration Program version 5.0.2 by Stuiver and Reimer also presented in Appendix C.

A summary of the Carbon-14 test results are presented in Table I, that follows:

TABLE I
CARBON 14 TEST RESULTS

SAMPLE ID	SAMPLE LOCATION	REPORTED AMS C^{14} AGE DETERMINATION (YEARS)	CALIBRATED AMS C^{14} AGE (CALENDAR YEARS AGO)
C-2	Trench ET-1, Station 1+13.5, bottom of trench (BOT)	7520 +/-50	8400
C-3	Trench ET-1, Station 1+04, 0.5 foot above BOT	6600 +/- 60	7600
C-5	Trench ET-4, Station 1+27, 1 foot above BOT	4160 +/- 50	4760

Based upon review of the results, the age determinations from Trench ET-1 ranged from 8,400 (Sample C-2) to 7,600 (Sample C-3) calendar years. Using the deepest carbon sample (Sample C-2), the findings of Trench ET-1 indicate that sediments at least 8,400 years old have not been offset by faulting. As noted above, an older alluvium unit was encountered from the southern end of the trench to approximately Station 1+05 underlying the unit where carbon Sample C-2 was obtained. This alluvial soil is older than 8,400 calendar years based on the date determined for carbon Sample C-2 and based on soil chronology by Dr. Borchert, this unit appears to be at least 13,000 years old (pre-Holocene in age).

Review of the age determination results for Sample C-5 from Trench ET-4 reported a soil age of 4,760 calendar years ago. The unit in which charcoal Sample C-5 was recovered probably correlates with the channel fill encountered in the upper portion of Trench ET-1.

CONCLUSIONS

Although the focus study area is located outside the State of California Earthquake Fault Hazard Zones (1982), the focus study area is located within City of San Jose Potential Fault Hazard Zone (1983) for the Shannon fault (portion of Fault 9 north of Bailey Avenue, Figures 2 and 3).

Incorporating the information from pedochronologic study and associated Carbon-14 age determination, alluvial soils exposed near the base of Trench ET-1 between Station 0+00 to Station 1+04 appear to be at least 13,000 years old; alluvial soil between Station 1+04 to 1+45 appears to be at least 8,400 years old; and pre-Holocene bedrock was exposed from Station 1+45 to the north end of the trench. Based on these findings, it is reasonable to conclude that no indications of active faulting were found from Station 0+00 to about 1+04 or from Station 1+45 to 1+67. The data collected do not conclusively demonstrate that no active faulting occurs from Station 1+04 to Station 1+45; however, given that the alluvial soil strata in question is at least 8,400 years old and does not exhibit indications of faulting, it is unlikely that an active fault exists in this section of the trench.

Shear features and contacts between the Franciscan rock types encountered in Trenches ET-1A, ET-2, ET-3 and ET-3A appeared to be associated with older tectonic deformations of the Franciscan rock. These shears were generally observed to be discontinuous, undulating and in orientations that are not consistent with the mapped trend of the Shannon fault. Ground parallel shear features encountered near the soil/rock contact in Trenches ET-3 and ET-3A were observed to be discontinuous and curved on a small scale, and appear to be associated with soil creep.

Based on the findings of this limited fault exploration, no indications of Holocene-age faulting or seismic ground deformation were observed within the focus study area. Additionally, no indications of faulting were encountered in the study area where a setback zone had been previously recommended by Lowney-Kaldveer Associates (1974). As described above, the results of soil stratigraphic study and carbon dating indicate that pre-Holocene soil or bedrock was encountered in most of Trench ET-1. Additionally, pre-Holocene Franciscan bedrock was encountered in Trenches ET-1A, ET-2, ET-3 and ET-3A, on the north end of Trench ET-1 and the northeast and southwest ends of Trench ET-4.

The faults and lineaments previously mapped in this focus study area do not appear to be active and the potential for ground rupture along these faults is considered unlikely. In-active faults may cross the study area at depth and may be concealed by Holocene and Pleistocene alluvial deposits in the valley.

As a result of our fault exploration and prior fault studies, it is our opinion that it is reasonable to proceed with land planning within the Urban Reserve without fault setback restrictions. However, it is the opinion of the City Geologist that additional fault exploration in conjunction with geotechnical studies would be required for development on individual parcels within the mapped fault zone. These studies should be performed in coordination with input from the City or County jurisdiction. It is possible that if a sufficient number of studies are produced with negative results, the City and County Geologists may determine that no further exploration is needed and development can proceed within the zone without additional fault studies.

LIMITATIONS AND UNIFORMITY OF CONDITIONS

This report is issued with the understanding that it is the responsibility of the owner to transmit the information and recommendations of this report to developers, buyers, architects, engineers, and designers for the project. The conclusions and recommendations contained in this preliminary report are solely professional opinions.

The professional staff of ENGEO Incorporated strives to perform its services in a proper and professional manner with reasonable care and competence but is not infallible. There are risks of earth movement and property damages inherent in land development. We are unable to eliminate all risks or provide insurance; therefore, we are unable to guarantee or warrant the results of our service.

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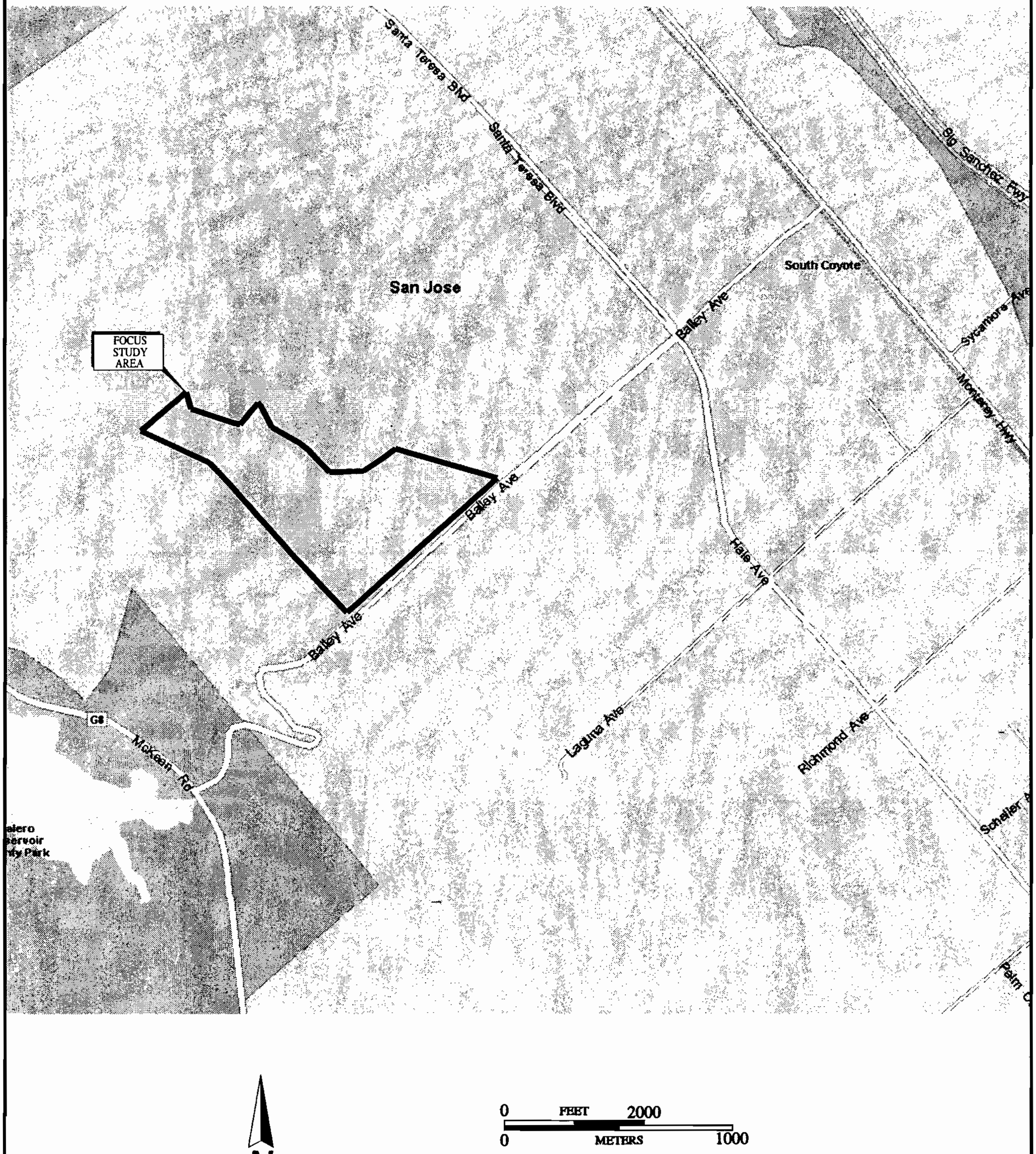
LIST OF FIGURES



BASE MAP SOURCE: MS STREETS AND TRIPS

ENGEO INCORPORATED EXCELLENT SERVICE SINCE 1971	VICINITY MAP COYOTE VALLEY SPECIFIC PLAN AREA SAN JOSE, CALIFORNIA	PROJECT NO.: 5969.3.004.01 DATE: JULY 2006 DRAWN BY: SRP CHECKED BY: JAM	FIGURE NO. 1

ORIGINAL FIGURE PRINTED IN COLOR

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EXPLANATION

CITY OF SAN JOSE SPECIAL STUDIES ZONE

CITY OF SAN JOSE POTENTIAL HAZARD ZONE

REPORTED FAULTS

N

0 MILES 1

0 KILOMETERS 2

BASE MAP SOURCE: CITY OF SAN JOSE, 1983

ENGEO INCORPORATED EXCELLENT SERVICE SINCE 1971	FAULT HAZARD ZONES COYOTE VALLEY SPECIFIC PLAN AREA SAN JOSE, CALIFORNIA	PROJECT NO.: 5969.3.004.01 DATE: JULY 2006 DRAWN BY: SRP CHECKED BY: JAM	FIGURE NO. 2

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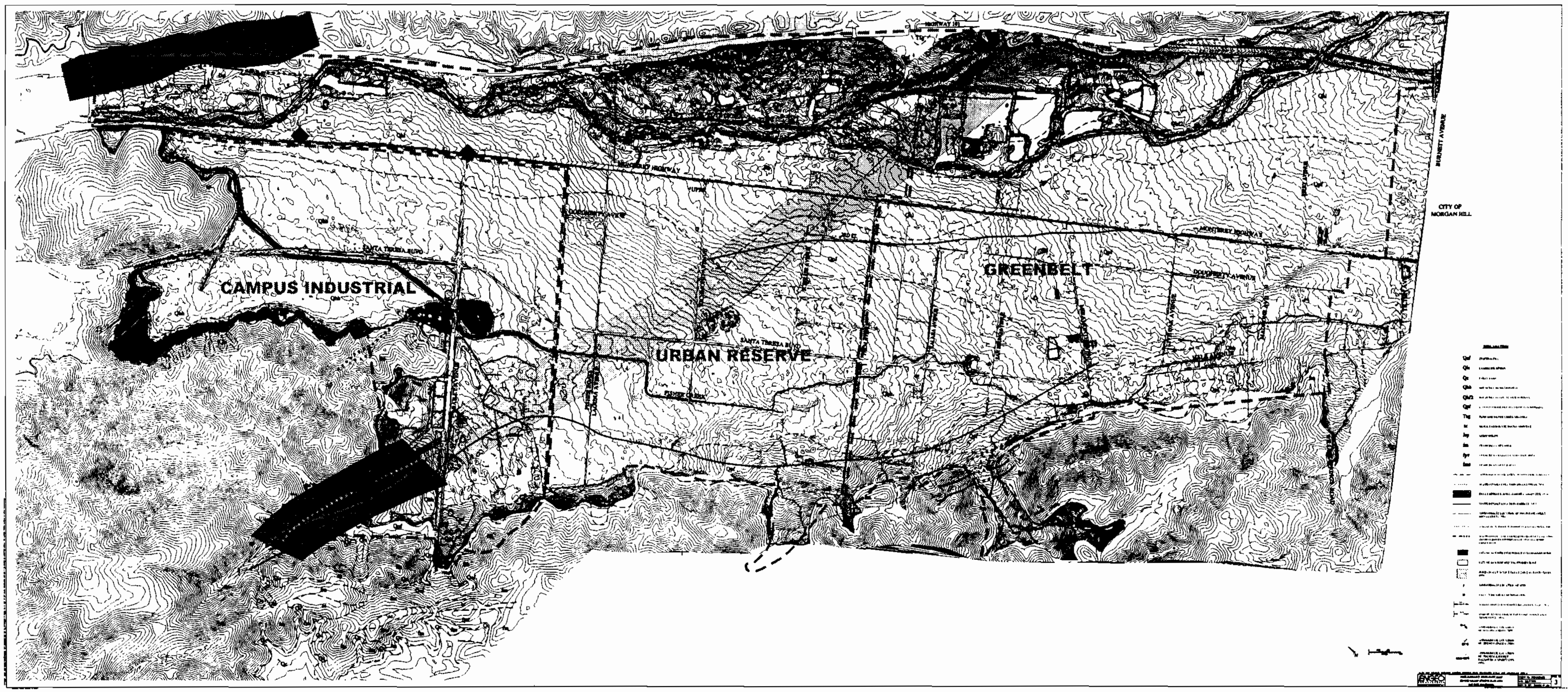
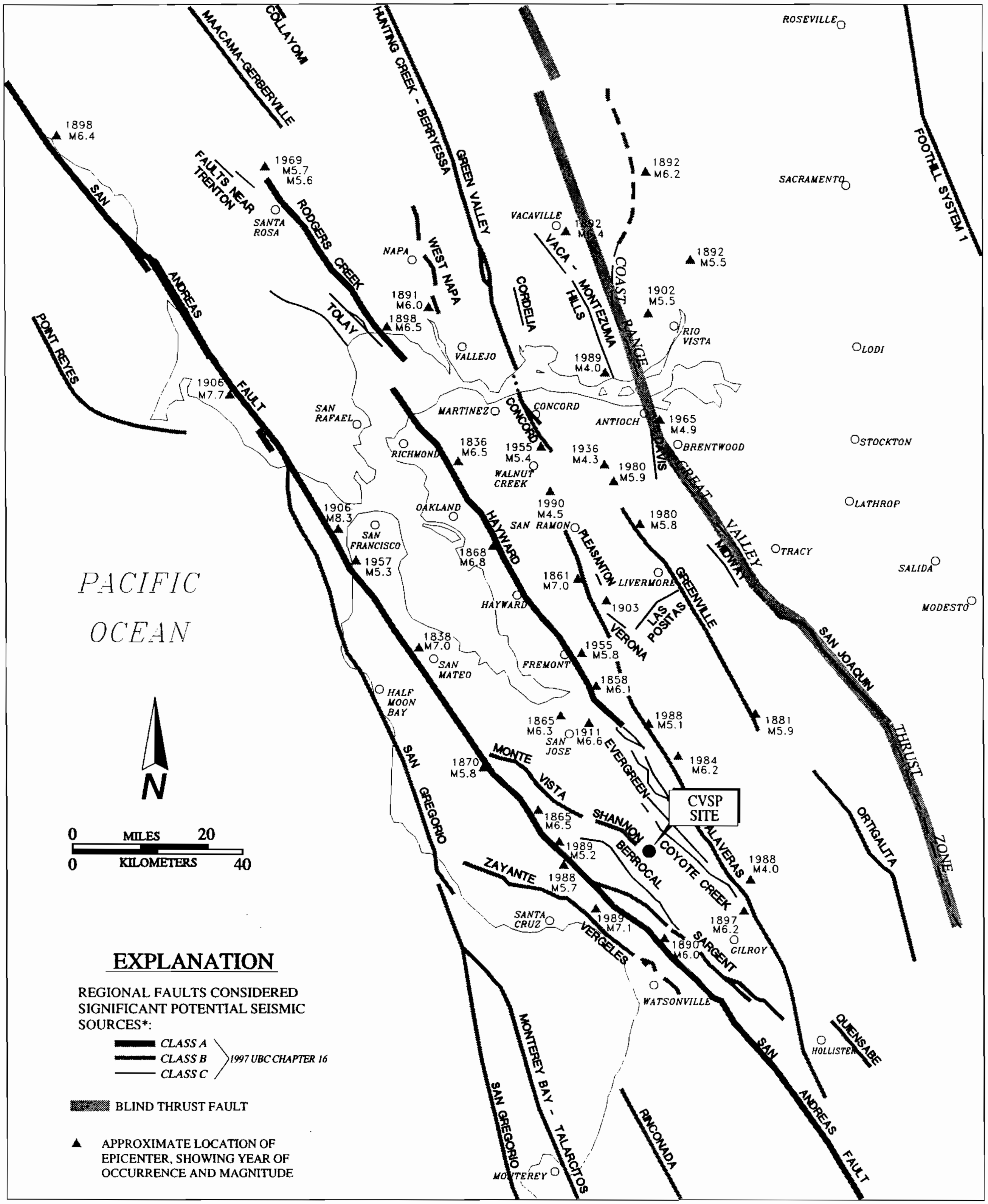

CAMPUS INDUSTRIAL
URBAN RESERVE
GREENBELT
CITY OF MORGAN HILL
BURNETT AVENUE
SANTA TERESA BLVD
MONTEREY HIGHWAY
HIGHWAY 101



EXPLANATION

REGIONAL FAULTS CONSIDERED SIGNIFICANT POTENTIAL SEISMIC SOURCES*:

- CLASS A
- CLASS B
- CLASS C

1997 UBC CHAPTER 16

BLIND THRUST FAULT

▲ APPROXIMATE LOCATION OF EPICENTER, SHOWING YEAR OF OCCURRENCE AND MAGNITUDE

*BASED ON USGS OPEN FILE 96-706

ENGEO INCORPORATED
EXCELLENT SERVICE SINCE 1971

REGIONAL FAULTING AND SEISMICITY
COYOTE VALLEY SPECIFIC PLAN AREA
SAN JOSE, CALIFORNIA

PROJECT NO.: 5969.3.004.01	FIGURE NO. 4
DATE: JULY 2006	
DRAWN BY: SRP	CHECKED BY: JAM

ORIGINAL FIGURE PRINTED IN COLOR

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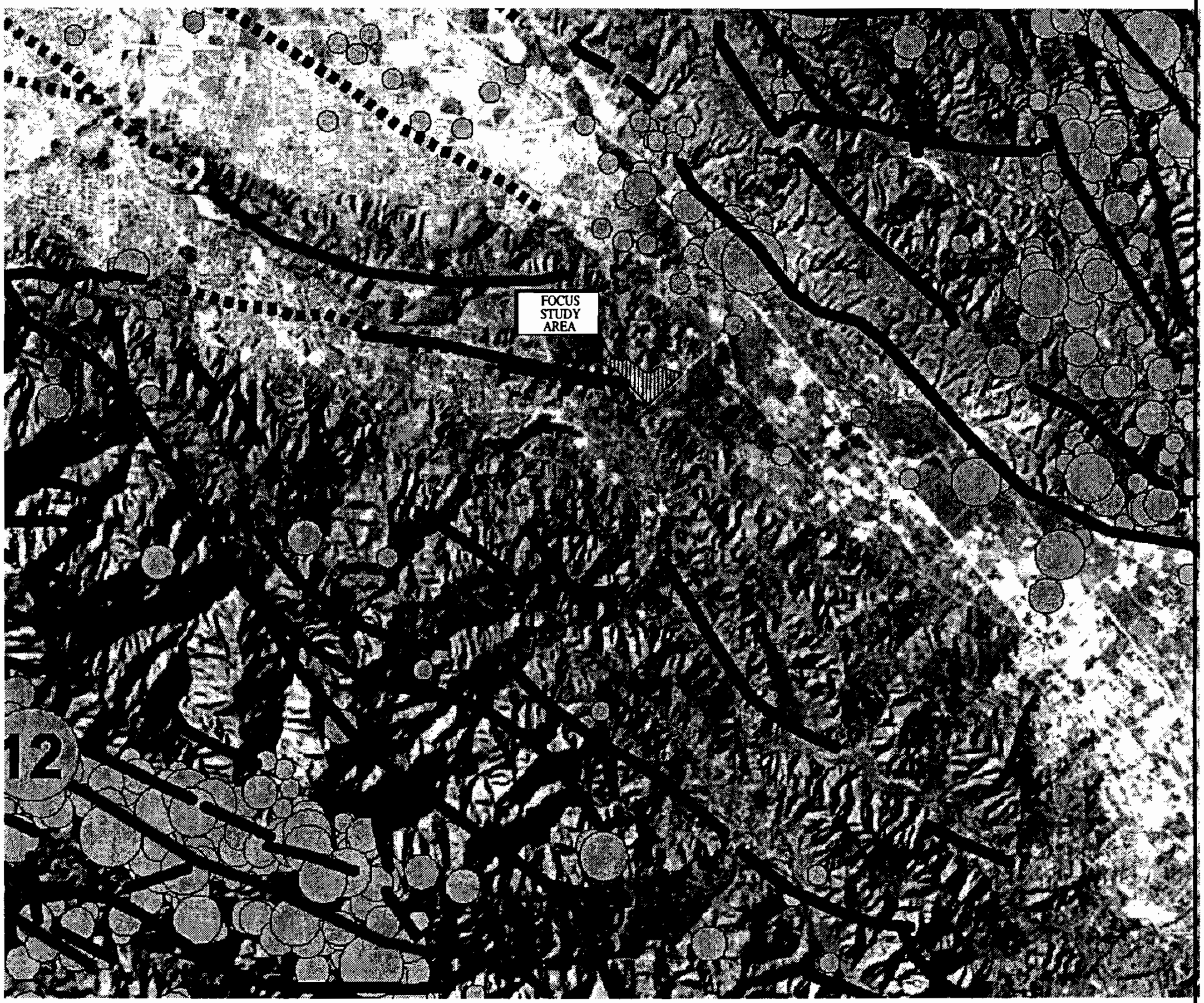

EXPLANATION

EARTHQUAKES

MAGNITUDE (RICHTER)

1.5 - 2.0
2.1 - 3.0
3.1 - 4.0
4.1 - 5.0
5.1 - 6.0
6.1 - 7.0

14 Number refers to earthquake number in table

BATHYMETRY

Sea level

3,650 Meters

FAULTS – Dashed where approximately located; dotted where inferred

Active in last 700,000 years
Active prior to 700,000 years ago

N

0 FEET 10000
0 METERS 5000

BASE MAP SOURCE: SLEETER et al, 2004

ENGEO INCORPORATED EXCELLENT SERVICE SINCE 1971	LOCAL EARTHQUAKES AND FAULTS COYOTE VALLEY SPECIFIC PLAN AREA SAN JOSE, CALIFORNIA	PROJECT NO.: 5969.3.004.01 DATE: JULY 2006 DRAWN BY: SRP CHECKED BY: JAM	FIGURE NO. 5

ORIGINAL FIGURE PRINTED IN COLOR

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EXPLANATION

TP-7 APPROXIMATE LOCATION OF TEST PIT (THIS STUDY)

— — — LINEAMENT

ET-3 APPROXIMATE LOCATION OF TRENCH (THIS STUDY)

N

0 FEET 500
0 METERS 250

BASE MAP SOURCE: U.S.G.S.

ENGEO INCORPORATED EXCELLENT SERVICE SINCE 1971	FAULT EXPLORATION LOCATIONS COYOTE VALLEY SPECIFIC PLAN SAN JOSE, CALIFORNIA	PROJECT NO.: 5969.3.004.01 DATE: JULY 2006 DRAWN BY: SRP CHECKED BY: JAM	FIGURE NO. 6

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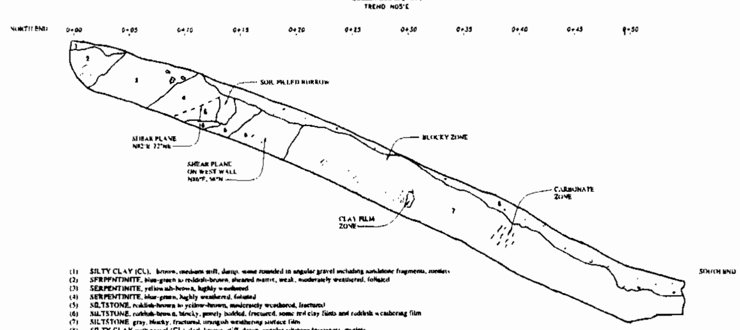
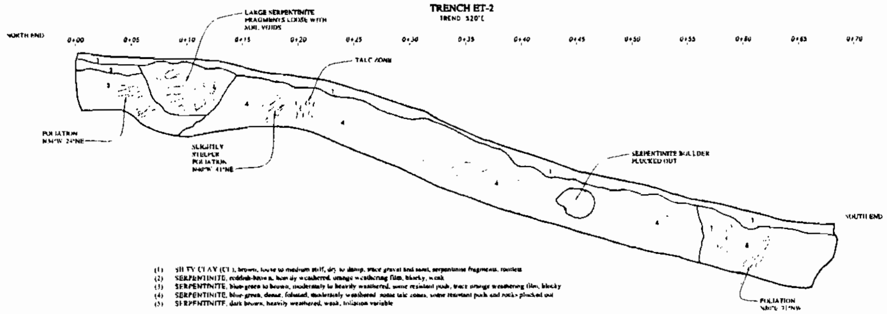
TRENCH ET-1A
TREND N05°E



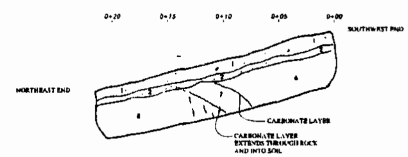
(1) SILTY CLAY (CL), brown, medium stiff, damp, some rounded to angular gravel including sandstone fragments, rootlets
(2) SERPENTINITE, blue-green to reddish-brown, sheared matrix, weak, moderately weathered, foliated
(3) SERPENTINITE, yellowish-brown, highly weathered
(4) SERPENTINITE, blue-green, highly weathered, foliated
(5) SILTSTONE, reddish-brown to yellow-brown, moderately weathered, fractured
(6) SILTSTONE, reddish-brown, blocky, poorly bedded, fractured, some red clay films and reddish weathering film
(7) SILTSTONE, gray, blocky, fractured, orangish weathering surface film
(8) SILTY CLAY with gravel (CL), dark brown, stiff, damp, angular siltstone fragments, rootlets.

TRENCH ET-2
TREND 320°E



(1) SILTY CLAY (CL), brown, loose to medium stiff, dry to damp, trace gravel and sand, serpentinite fragments, rootlets
(2) SERPENTINITE, reddish-brown, heavily weathered, orange weathering film, blocky, weak
(3) SERPENTINITE, blue-green to brown, moderately to heavily weathered, some resistant pods, trace orange weathering film, blocky
(4) SERPENTINITE, blue-green, dense, foliated, moderately weathered, some talc zones, some resistant pods and rocks plucked out
(5) SERPENTINITE, dark brown, heavily weathered, weak, foliation variable

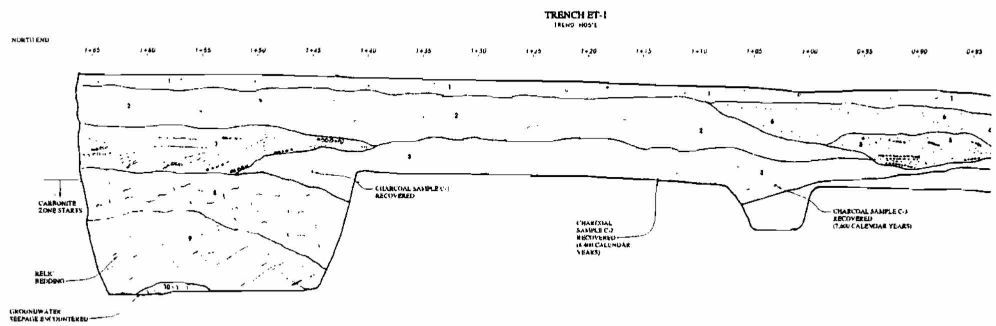
TRENCH ET-3A
TREND N88°E

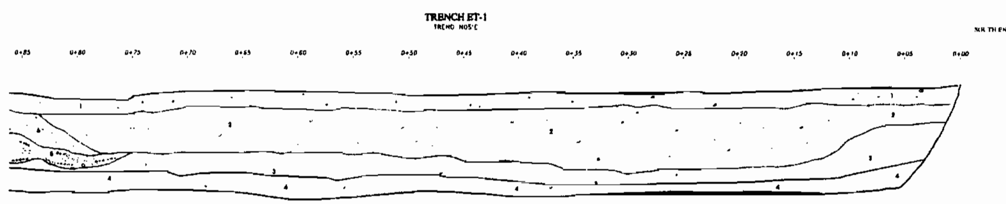


(1) SILTY CLAY (CL), dark brown, medium stiff, damp, trace gravel, rootlets
(2) SILTY CLAY (CL), dark brown, stiff, moist, trace gravel, serpentinite fragments, shear/soil parting at soil/rock contact, carbonate zone extend from lower rock into soil, soil creep at soil/rock contact
(6) SERPENTINITE, brown to green-brown, moderately weathered, weak, variable foliations, through going carbonate veins into overlying soil
(7) SERPENTINITE, green, soft, weak, moderately weathered, foliated, talc zones, internal shears, carbonate zone through rock and overlying soil
(8) SILTSTONE, reddish-brown to brown, moderately weathered, range from dense/blocky to weak, friable and foliated, reddish weathering film
(9) SERPENTINITE, blue-green, vertical foliation, soft, serpentinite pod in siltstone

ENGEO INCORPORATED	FAULT EXPLORATION TRENCH LOGS COYOTE VALLEY SPECIFIC PLAN AREA SAN JOSE, CALIFORNIA	PROJECT NO. 5969.3.004.01 DATE JULY 2006 DRAWN BY SRP CHECKED BY JAM FIGURE NO. 7

1"=5'





(1) SILTY CLAY (CL), brown to very dark grayish brown with minor reddish-brown mottling, medium stiff, damp, with trace rounded to angular gravel including sandstone fragments, rootlets. Regularly tilled agriculture cropland.
(2) SILTY CLAY (CL), dark brown to very dark grayish brown, stiff, moist, trace reddish and yellowish-brown sandstone, siltstone and serpentinite gravel, some blocky and prismatic structures, abundant charcoal fragments ranging from ⅛ to ¼ inch diameter
(3) SILTY CLAY (CL), dark brown, stiff, damp, some gravel sub-rounded to angular, trace sand, abundant charcoal fragments ranging from ⅛ to ¼ inch diameter.
(4) SANDY CLAY with silt (CL), dark brown, stiff, moist, friable, trace weathered angular pebbles, blocky structure, clay films.
(5) SANDY GRAVEL (GW), brown, medium dense, moist, gravel up to 4 inches in diameter consisting of siltstone, metasedimentary and serpentinite clasts, multiple fining upward pulses. Channel deposit.
(6) SAND with gravel (SW), brown, medium dense, moist, fine to coarse sand, gravel up to 1 inch in diameter consisting of siltstone, metasedimentary and serpentinite clasts. Channel deposit.
(7) SANDY GRAVEL (GW), brown, medium dense, moist, subrounded well sorted gravel up to 2 inches in diameter consisting of siltstone, metasedimentary and serpentinite clasts, multiple fining upward pulses. Channel deposit
(8) SILTY CLAY (CL), grayish-brown, stiff, moist, smooth undulating ped surfaces due to shrink/swell, highly weathered siltstone.
(9) SILTSTONE, grayish-brown to yellowish-brown, hard, very friable, moderately weathered, carbonate layers sub-parallel to bedding
(10) SERPENTINITE, blue-green, weak, soft, foliated, moderately weathered

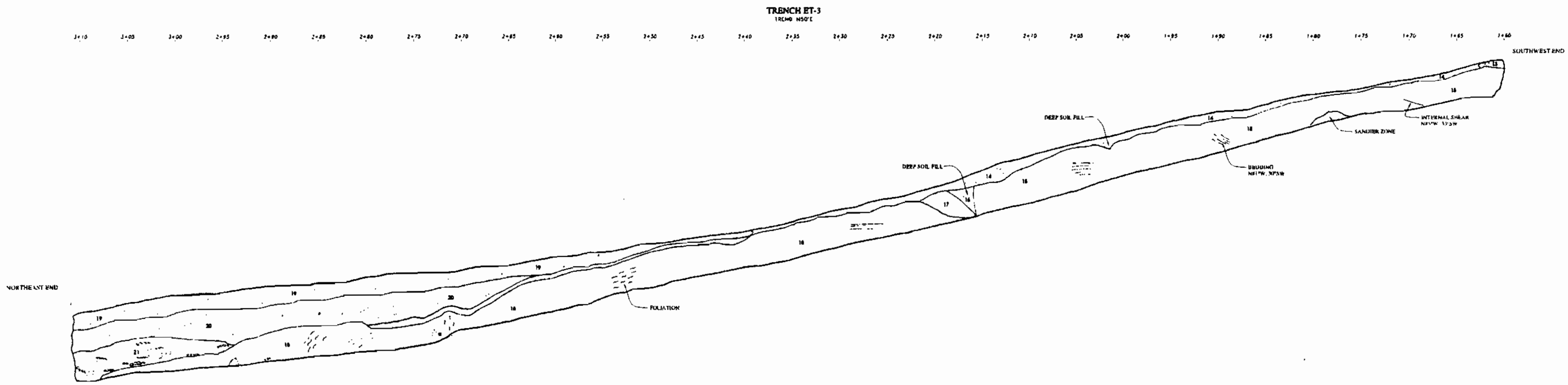
ENGEO INCORPORATED

FAULT EXPLORATION TRENCH LOGS
COYOTE VALLEY SPECIFIC PLAN AREA
SAN JOSE, CALIFORNIA

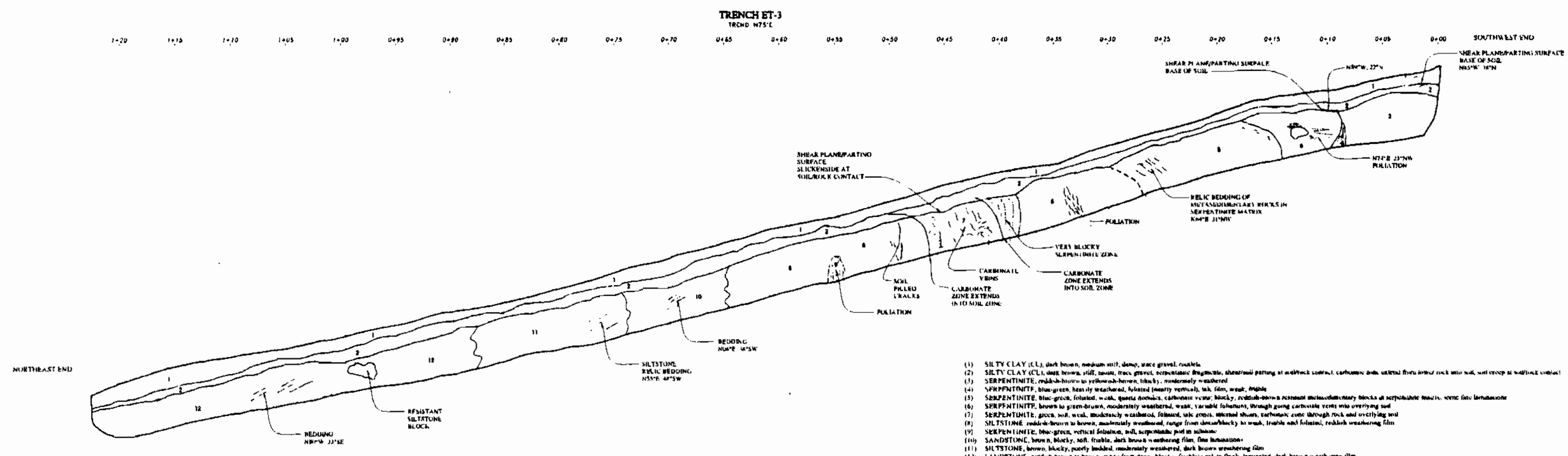
DATE: JULY 2006

8

TRENCH ET-3
TREND N50°E



TRENCH ET-3
TREND N75°E

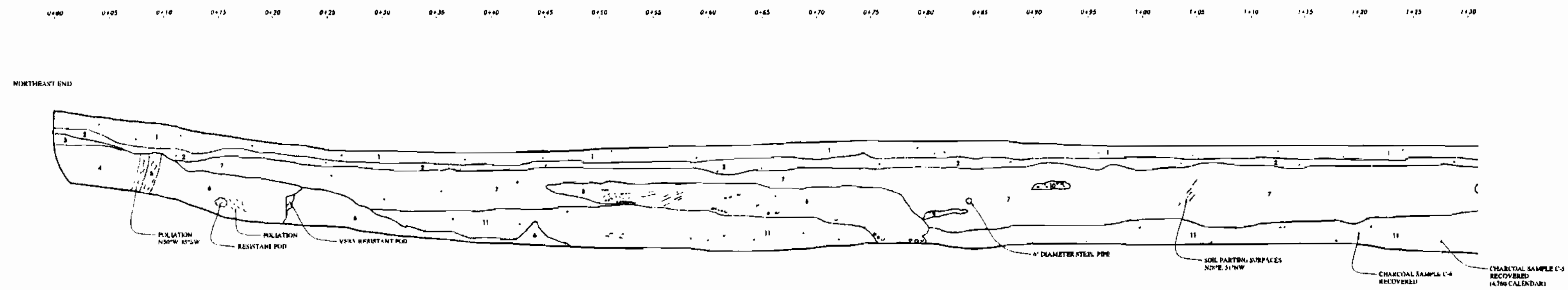


(1) SILTY CLAY (CL), dark brown, medium stiff, damp, trace gravel, rootlets
(2) SILTY CLAY (CL), dark brown, stiff, moist, trace gravel, serpentinite fragments, shear/soil parting at soil/rock contact, carbonate zone extend from lower rock into soil, soil creep at soil/rock contact
(3) SERPENTINITE, reddish-brown to yellowish-brown, blocky, moderately weathered
(4) SERPENTINITE, blue-green, heavily weathered, foliated (nearly vertical), talc film, weak, friable
(5) SERPENTINITE, blue-green, foliated, weak, quartz nodules, carbonate veins; blocky, reddish-brown resistant metasedimentary blocks at serpentinite matrix, some fine laminations
(6) SERPENTINITE, brown to green-brown, moderately weathered, weak, variable foliations, through going carbonate veins into overlying soil
(7) SERPENTINITE, green, soft, weak, moderately weathered, foliated, talc zones, internal shears, carbonate zone through rock and overlying soil
(8) SILTSTONE, reddish-brown to brown, moderately weathered, range from dense/blocky to weak, friable and foliated, reddish weathering film
(9) SERPENTINITE, blue-green, vertical foliation, soft, serpentinite pod in siltstone
(10) SANDSTONE, brown, blocky, soft, friable, dark brown weathering film, fine laminations
(11) SILTSTONE, brown, blocky, poorly bedded, moderately weathered, dark brown weathering film
(12) SANDSTONE, reddish-brown to brown, range from dense/blocky (friable/weak to finely laminated, dark brown weathering film
(13) SILTY CLAY with gravel (CL), dark brown, stiff, moist, rootlets, siltstone angular fragments. Road fill
(14) SILTY CLAY with rock fragments (CL), weathered bedrock, clay around rock fragments, weak, rootlets
(15) SILTSTONE, brown, blocky, weak, heavily weathered, dark brown weathering film, roots, friable-soft zones
(16) SILTY CLAY with siltstone fragments (CL), brown, loose, moist, soil fill in crack
(17) SERPENTINITE, blue-green to brown, moderately weathered, blocky, weakly foliated, some carbonate veins
(18) SERPENTINITE, blue-green, dense, foliated, blocky, some reddish weathered zones
(19) SILTY CLAY with gravel (CL), dark brown, stiff, damp, rootlets, charcoal fragments. Regularly tilled agriculture cropland.
(20) SILTY CLAY with gravel (CL), reddish-brown to brown, stiff, moist, reddish-brown sandstone fragments, charcoal fragments, roots, siltstone and serpentinite fragments
(21) SILTY SAND with gravel (SM), brown, medium dense, moist, fine to coarse sand, gravel up to 2 inch in diameter consisting of siltstone, metasedimentary and serpentinite clasts, multiple fining upward pulses. Channel deposit.
(22) SILTY CLAY with serpentinite fragments (CL), heavily weathered bedrock zone

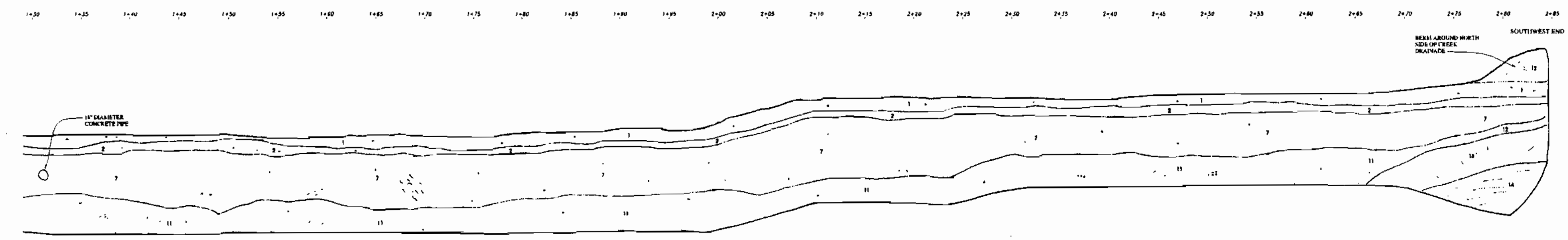
1"=5'

ENGEO INCORPORATED	FAULT EXPLORATION TRENCH LOGS COYOTE VALLEY SPECIFIC PLAN AREA SAN JOSE, CALIFORNIA	PROJECT NO. 5900.3.004.01 DATE JULY 2006 DRAWN BY SRP CHECKED BY JAM	FIGURE NO. 9

TRENCH ET-4
TREND S25°E



TRENCH ET-4
TREND S25°E



(1) SILTY CLAY (CL), dark brown, medium stiff, damp, rootlets, trace gravel (serpentinitic fragments)
(2) SILTY CLAY (CL), grayish-brown, stiff, damp to moist, mottles, trace gravel, smooth undulating ped surfaces due to shrink/swell, charcoal fragments
(3) SERPENTINITE, brown, heavily weathered, soil filling fractures, friable, weak
(4) SERPENTINITE, blue-green to reddish-brown, dense, moderately weathered, range from soft, weak, foliated (variable directions) to blocky
(5) SERPENTINITE, blue-green, blocky, resistant zone
(6) SERPENTINITE, blue-green to reddish-brown, moderately weathered, blocky
(7) SILTY CLAY (CL), brown, stiff, damp to moist, trace gravel consisting of reddish and brown sandstone and serpentinitic fragments, roots up to ½ inch diameter, smooth undulating ped surfaces due to shrink swell, charcoal fragments
(8) SANDY GRAVEL (GW), brown, medium dense, moist, roots, gravel up to 4 inches in diameter consisting of siltstone and serpentinite clasts, multiple fining upward pulses, fine gravel and sand around clasts, charcoal fragments. Channel deposit
(9) SILTY CLAY (CL), paleosol, dark brown, roots
(10) SANDY GRAVEL (GW), brown, loose, moist, roots, gravel up to 4 inches in diameter consisting of siltstone and serpentinite clasts, multiple fining upward pulses
(11) SILTY CLAY with sand (CL), dark brown, stiff, moist, trace gravel, charcoal fragments
(12) SILTY CLAY with gravel (CL), dark brown, medium stiff, damp, serpentinite, sandstone and siltstone fragments. Fill for stream drainage berm
(13) SILTY CLAY (CL), grayish-brown, stiff, moist, smooth undulating ped surfaces due to shrink swell, highly weathered/reworked siltstone
(14) SILTSTONE, yellowish-brown, moderately weathered, hard, blocky, poorly bedded, orange weathered film

1"=5'

ENGEO INCORPORATED

FAULT EXPLORATION TRENCH LOGS
COYOTE VALLEY SPECIFIC PLAN AREA
SAN JOSE, CALIFORNIA

PROJECT NO. 5960.3.004.01
DATE JULY 2006
DRAWN BY SRP | CHECKED BY JAM
DRAWING NO. 10

APPENDIX A

ENGEO INCORPORATED

Test Pit Logs

TEST PIT LOGS

Test Pit Number	Depth (feet)	Description
TP-1	0 – 2	SILTY CLAY (CL), dark brown, damp, stiff, rootlets, trace gravel, sandstone fragments
	2 – 4	SILTSTONE, yellowish-brown, moderately weathered, orangish-brown weathered surfaces
		Total depth approximately 4 feet Groundwater was not encountered
TP-2	0 – 1	SILTY CLAY (CL), dark brown, damp, stiff, rootlets, trace gravel
	1 - 3	SILTSTONE, yellowish-brown, massive, blocky, poorly bedded, moderately weathered
		Total depth approximately 3 feet Groundwater was not encountered
TP-3	0 – 1.5	SILTY CLAY (CL), dark brown, damp, stiff, rootlets, trace gravel
	1.5 – 3	SILTSTONE, yellowish-brown, massive, blocky, poorly bedded, heavily weathered
	3 – 4.5	SILTSTONE, yellowish-brown, massive, blocky, poorly bedded, moderately weathered
		Total depth approximately 4.5 feet Groundwater was not encountered
TP-4	0 – 1	SILTY CLAY (CL), grayish-brown, damp, medium stiff, rootlets, trace gravel, tilled agriculture cropland
	1 – 5	SILTY CLAY (CL), dark-brown, moist, medium stiff, rootlets, trace gravel, brown and reddish-brown sandstone and serpentinite fragments, charcoal fragments

TEST PIT LOGS

Test Pit Number	Depth (feet)	Description
	5 – 9	SILTY CLAY (CL), gray, moist, medium stiff, heavily weathered
	9 – 10	SERPENTINITE, blue-green, foliated, heavily weathered
	10 – 12	SERPENTINITE, blue-green, foliated, moderately weathered, soft, weak
		Total depth approximately 12 feet Groundwater was not encountered
TP-5	0 – 1	SILTY CLAY (CL), grayish-brown, damp, medium stiff, rootlets, trace gravel,
	1 – 5	SILTY CLAY (CL), dark-brown, moist, medium stiff, rootlets, trace gravel, brown and reddish-brown sandstone and serpentinite fragments, charcoal fragments
	5 – 8	SERPENTINITE, blue-green, foliated, moderately weathered, soft, some dense resistant pods
		Total depth approximately 8 feet Groundwater was not encountered
TP-6	0 – 2	SILTY CLAY (CL), grayish-brown, damp, medium stiff, rootlets, trace gravel
	2 – 8	SILTY CLAY (CL), reddish-brown, moist, medium stiff, rootlets, trace gravel, brown and reddish-brown sandstone and serpentinite fragments, charcoal fragments
	8 – 21	SILTY CLAY (CL), dark-brown, moist, medium stiff, rootlets, trace gravel, brown and reddish-brown sandstone and serpentinite fragments, charcoal fragments
		Total depth approximately 21 feet Groundwater was not encountered
TP-7	0 - 1	SILTY CLAY (CL), grayish-brown, damp, medium stiff,

TEST PIT LOGS

Test Pit Number	Depth (feet)	Description
		rootlets, trace gravel
	1 – 2	SILTY CLAY (CL), dark-brown, moist, medium stiff, rootlets, trace gravel, brown and reddish-brown sandstone and serpentinite fragments, charcoal fragments
	2 – 6	SERPENTINITE, blue-green, foliated, moderately weathered, soft, some dense resistant pods
		Total depth approximately 6 feet Groundwater was not encountered

APPENDIX B

SOIL TECTONICS

Pedochronological Report

5969.3.004.01
July 7, 2006

PEDOCHRONOLOGICAL REPORT FOR THE COYOTE VALLEY SPECIFIC PLAN AREA, SAN JOSE, CALIFORNIA

January 31, 2006

ENGEO, Inc., San Jose, CA Project No. 5969.3.004.01

Soil Tectonics
P.O. Box 5335
Berkeley, CA 94705

GBorchardt

Glenn Borchardt

Principal Soil Scientist
Certified Professional Soil Scientist No. 24836

PEDOCHRONOLOGICAL REPORT FOR THE COYOTE VALLEY SPECIFIC PLAN AREA, SAN JOSE, CALIFORNIA

January 31, 2006

ENGEO, Inc., San Jose, CA Project No. 5969.3.004.01

Soil Tectonics
P.O. Box 5335
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Glenn Borchardt

INTRODUCTION

An assessment of seismic risk due to fault rupture can be aided greatly by the techniques of pedochronology (Borchardt, 1992, 1998), soil dating. This is because the youngest geological unit overlying fault traces is generally a soil horizon. The age and relative activity of faulting often can be estimated by evaluating the age and relative tectonic disturbance of overlying soil units.

Soil horizons exhibit a wide range of physical, chemical, and mineralogical properties that evolve at varying rates. Soil scientists use various terms to describe these properties. A black, highly organic "A" horizon, for example, may form within a few centuries, while a dark brown, clayey "Bt" horizon may take as much as 40,000 years to form. Certain soil properties are invariably absent in young soils. For instance, soils developed in granitic alluvium of the San Joaquin Valley do not have Munsell hues redder than 10YR until they are at least 100,000 years old (Birkeland, 1999; Harden, 1982). Still other properties, such as the movement and deposition of clay-size particles and the precipitation of calcium carbonate at extraordinary depths, indicate soil formation during a climate much wetter than at present. In the absence of a radiometric age date for the material from which a particular soil formed, an estimate of its age must take into account all the known properties of the soil and the landscape and climate in which it evolved.

METHOD

The first step in studying a soil is the compilation of the data necessary for describing it (Birkeland, 1999; Borchardt, 2004). At minimum, this requires a Munsell color chart, hand lens, acid bottle, meter for 1:1 soil:water pH and conductivity measurements. The second step may involve the collection of samples of each horizon for laboratory analysis of particle size. This is done to check the textural classifications made in the field and to evaluate the genetic relationships between horizons and between different soils in the landscape. When warranted, the clay mineralogy and chemistry of the soil is also analyzed in order to provide additional information on the changes undergone by the initial material from which the soil weathered. The last step is the comparison of this accumulated soil data with that for soils having developed under similar conditions. Such information is scattered in soil survey reports (e.g., Welch and others, 1966), soil science journals, and consulting reports. In a particular locality, there is seldom enough comparative data available for this purpose. That is why, at the very least, the study of one soil profile always makes the evaluation of the next that much easier.

RESULTS OF THIS EVALUATION

Two soil profiles were studied in this trench across a suspect trace of the Shannon fault system. At one extreme, Soil Profile No. 1 was developed entirely in fine-grained overbank alluvium. At the other extreme, Soil Profile No. 2 was developed in what appeared to be the youngest channel fill in the trench.

Soil Profile No. 1

This profile has a 28-cm thick very dark grayish brown clay loam A horizon over a 202-cm thick dark brown light clay to clay loam Bt horizon overlying sandy clay loam to heavy sandy loam BCt and CBt horizons (Table 1). Although the soil colors are dark and the soil structure is mostly subangular blocky, the clay film development is pervasive, with a few medium thick films reaching depths of at least 280 cm. The Bt horizon is strongly acid at the 50-cm depth (Fig. 1). Most of the alluvium was derived from the surrounding hills, as the clasts in this profile tend to be angular and there are quite a few faint yellowish red (5YR4/6m, 6/6d) to prominent red (2.5YR5/6md) peds reworked from a previous soil. A road cut 412 m to the southwest exposed a yellowish red Bt horizon in a soil developed on sandstone of the Franciscan Complex. The conductivity approached a maximum in the B3t horizon (Fig. 2). This indicates that current leaching seldom reaches the depth at which the clay films in that horizon were deposited (>142 cm, Table 1).

Soil Profile No. 2

This profile also has a 28-cm thick very dark grayish brown clay loam A horizon. It overlies a 45-cm thick clay loam to gravelly clay loam BAt horizon, so designated because it is very dark grayish brown (and A horizon characteristic) *and* has common thin to medium thick clay films on pores, clasts, and peds (a B horizon characteristic). This overlies loamy sand and gravelly loamy sand layers that define a prominent channel fill at this station. Only a few thin clay films exist on the clasts at the base of this soil (Table 1). Clay films then become much thicker and more common in the underlying Bt horizons formed in gravelly clayey sand and clay loam paleosol (Table 1). The pH measurements reflect the changes in parent material textures as well as the more varied pedogenesis in this profile (Fig. 1). The clasts in the lower half of this profile tend to be subrounded, reflecting the slightly more rigorous abrasion that occurred in this channel area. Nevertheless, there still are a few faint yellowish red (5YR4/6m, 6/6d) to prominent red (2.5YR5/6md) peds reworked from a previous soil.

Age

Despite the dark brown colors, these soil profiles contain extensive evidence for Bt horizon development. Soil Profile No. 1 has a 202-cm thick Bt horizon, with about 88 cm of this showing evidence of having formed when precipitation was two or three times what it is at present. The BAt horizon in Soil Profile No. 2 is only 45 cm thick, so by this measure, soil development in the upper portion of the channel fill at station 85' is about ¼ that of the soil development in Soil Profile No. 1. Nevertheless, the paleosol beneath the channel fill has pedogenesis similar to that of Soil Profile No. 1, indicating that it began to form at about the same time (at 13 ka, Table 1). The 4.8-ka age from immediately beneath the most recent channel fill in nearby Trench ET-4 indicates that it probably is correlative with the channel fill in the upper 2 m of Soil Profile No. 2.

C-14 ages were determined from a fine horizontal unit (Ab horizon) containing much disseminated charcoal at the 260-cm depth. The age for the charcoal sampled at station 104' was 7.6 ka and the age for the charcoal sampled at station 113.5' was 8.4 ka (see main report). A correlative Ab horizon was not observed at the 260-cm depth in this 4Btb horizon at station 85' (Table 1). It also was not observed at the 260-cm depth in the BCt horizon of Soil Profile No. 1 at station 30'. These data imply that Soil Profile No. 1 and the paleosol in Soil Profile No. 2 were in existence when the charcoal of the Ab horizon was deposited in a broad, flat-bottomed channel at the northern end of the trench. This, along with the overlying <4.8-ka channel fill, supports the view that the northern end of Trench ET-1 is younger than the southern end.

CONCLUSIONS

1. The Bt horizons in these soil profiles appear to have begun forming before the Holocene-Pleistocene transition at 10 ka.
2. The thickness of the Bt horizons and their other characteristics indicate that the Bt horizon in Soil Profile No. 1 and the paleosol in Soil Profile No. 2 probably started to form at about 13 ka (13,000 calendar years ago).
3. The stream that cut the most recent channel appears to have abandoned this trench about 4,000 years ago.
4. Both soil profiles have sufficient soil development characteristics to assess the seismic hazard due to ground rupture at the site.
5. No shearing or other seismic deformation was observed within Trench ET-1.

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Table 1. Descriptions of soil profiles in Trench ET-1 across a suspect trace of the Shannon fault system in Coyote Valley, San Jose, California. Abbreviations are given in USDA-Natural Resources Conservation Service publications (Soil Survey Staff, 1993, 1999; 2003).

Described by Glenn Borchardt on October 11, 2005 in the east wall of Trench ET-1 at about 285' (GPS) elevation at 37.1942666° latitude and 121.75505° longitude. Parent material is alluvium. Mediterranean climate with MAP (mean annual precipitation) being 14.51" (San Jose) and 21.48" (Morgan Hill). Vegetation grass (formerly orchard). Good drainage. Slope 0.5%. Aspect E. The surface soil is medium acid and the subsoil is strongly acid.

Horizon	Depth, cm	Description

Soil Profile No. 1, Station 30'

A 0-28 Very dark grayish brown (10YR3/2m, 4/2d) clay loam with rare fine faint yellowish red (5YR4/6m, 6/6d) mottles due to peds reworked from a previous soil; fine to coarse strong granular to subangular blocky structure; sticky and plastic when wet, very friable when moist, and extremely hard when dry; few fine roots; many fine to medium continuous random tubular pores; few angular clasts to 4 cm; clear smooth boundary; pH 5.9; conductivity 90 uS (Sample No. 05B331).

B1t 28-71 Dark to very dark grayish brown (10YR3.5/2m, 4.5/2d) light clay with rare fine faint yellowish red (5YR4/6m, 6/6d) mottles due to peds reworked from a previous soil; medium strong granular to subangular blocky to weak angular blocky structure; sticky and plastic when wet, very friable when moist, and very hard when dry; many fine to medium continuous random tubular pores; many thin to medium thick clay films on pores, clasts, and peds; few angular clasts to 3 cm; traces of charcoal; clear smooth boundary; pH 5.3; conductivity 90 uS (Sample No. 05B332).

B2t 71-142 Dark brown (10YR4/3md) light clay with rare fine faint yellowish red (5YR4/6m, 6/6d) mottles and common fine to medium distinct yellow (10YR7/6md) mottles due to peds and weathered angular pebbles reworked from a previous soil; medium strong subangular blocky to weak angular blocky structure; very sticky and very plastic when wet, very friable when moist, and very hard when dry; many fine to medium continuous random tubular pores; many medium thick clay films on pores, clasts, and peds; few angular clasts to 2 cm; diffuse smooth boundary; pH 5.8; conductivity 80 uS (Sample No. 05B333).

B3t 142-230 Dark brown (10YR3/3m, 5/3d) clay loam with rare fine faint yellowish red (5YR4/6m, 6/6d) mottles and common fine to medium distinct yellow (10YR7/6md) mottles due to peds and weathered angular pebbles reworked from a previous soil; medium strong granular to moderate prismatic structure; sticky and plastic when wet, very friable when moist, and very hard when dry; common to many fine continuous random tubular pores; many medium thick clay films on pores, clasts, and peds; diffuse smooth boundary; pH 6.1; conductivity 140 uS (Sample No. 05B334).

BCt 230-266 Dark brown (10YR4/3m, 5/3d) sandy clay loam with rare fine faint yellowish red (5YR4/6m, 6/6d) mottles and common fine to medium distinct yellow (10YR7/6md) mottles due to peds and weathered angular pebbles reworked from a previous soil; massive to medium weak subangular blocky structure; sticky and plastic when wet, very friable when moist, and very hard when dry; common to many fine continuous random tubular pores; many medium thick clay films on pores and clasts; clear wavy boundary; pH 6.1; conductivity 80 uS (Sample No. 05B335).

CBt 266-280 Dark brown (10YR4/3m, 5/3d) heavy sandy loam; massive to medium weak subangular blocky structure; slightly sticky and slightly plastic when wet, very friable when moist, and very hard when dry; common to many fine continuous random tubular pores; few medium thick to thin clay films lining pores; few angular clasts to 3 cm; pH 5.8; conductivity 80 uS (Sample No. 05B336).

*ESTIMATED AGE: t_o = 13 ka
t_b = **0** ka
t_d = 13 ky

Soil Profile No. 2, Station 85'

A 0-28 Very dark grayish brown (10YR3/2m, 4/2d) clay loam; fine to medium strong granular structure; sticky and plastic when wet, very friable when moist, and extremely hard when dry; few fine roots; many fine to medium continuous random tubular pores; clear smooth boundary; pH 5.9; conductivity 160 uS (Sample No. 05B341).

BA1t 28-45 Very dark grayish brown (10YR3/2m, 4/2d) clay loam with rare fine faint yellowish red (5YR4/6m, 6/6d) mottles due to peds reworked from a previous soil; fine to medium strong granular and subangular blocky structure; very sticky and very plastic when wet, very friable when moist, and very hard when dry; few fine roots; many fine to medium continuous random tubular pores; common thin to medium thick clay films on pores, clasts, and peds; few angular clasts to 2 cm; diffuse smooth boundary; pH 5.6; conductivity 80 uS (Sample No. 05B342).

BA2t 45-73 Very dark grayish brown (10YR3/2m, 4/2d) gravelly clay loam with common fine faint yellowish red (5YR4/6m, 6/6d) mottles due to peds reworked from a previous soil; fine to medium strong subangular blocky structure; very sticky and very plastic when wet, very friable when moist, and very hard when dry; many fine to medium continuous random tubular pores; common thin to medium thick clay films on pores, clasts, and peds; clear smooth boundary; pH 5.5; conductivity 60 uS (Sample No. 05B343).

2BCt 73-126 Dark brown (10YR3/3m, 4/3d) loamy sand with common fine faint yellowish red (5YR4/6m, 6/6d) mottles and few fine faint red (2.5YR5/6md) mottles due to peds reworked from a previous soil; loose to medium weak subangular blocky structure; nonsticky and nonplastic when wet, very friable when moist, and very hard when dry; many fine to medium continuous random tubular and interstitial pores; common medium thick clay films on pores and clasts; subrounded clasts to 5 cm; diffuse smooth boundary; pH 5.9; conductivity 50 uS (Sample No. 05B344).

2CBt 126-205 Dark brown (10YR4/3md) gravelly loamy sand; loose to medium weak subangular blocky structure; nonsticky and nonplastic when wet, very friable when moist, and hard when dry; common fine to medium continuous random tubular and interstitial pores; few thin clay films on clasts; subrounded clasts to 4 cm; diffuse smooth boundary; pH 5.7; conductivity 50 uS [After this pedochronological estimate was made, a C-14 age of 4.8 ka was determined for charcoal beneath a correlative horizon in nearby Trench ET-4 (see main report).] (Sample No. 05B345).

*ESTIMATED AGE:	t_o =	4 ka
	t_b =	0 ka
	t_d =	4 ky

3Btb 205-250 Dark brown (10YR4/3m, 5/3d) gravelly clayey sand with few fine prominent red (2.5YR5/6md) mottles due to peds reworked from a previous soil; medium strong subangular blocky structure; very sticky and very plastic when wet, very friable when moist, and very hard when dry; many fine to medium continuous random tubular pores; common medium thick clay films on clasts and pores; subrounded clasts to 1 cm; diffuse smooth boundary; pH 6.3; conductivity 70 uS (Sample No. 05B346).

4Btb 250-265 Dark brown (10YR4/3m, 5/3d) clay loam with few fine prominent red (2.5YR5/6md) mottles due to peds reworked from a previous soil; medium strong subangular blocky structure; very sticky and very plastic when wet, very friable when moist, and very hard when dry; common fine to medium continuous random tubular pores; common thin to medium thick clay films on clasts and pores; pH 6.1; conductivity 80 uS [C-14 ages were later determined from a fine horizontal unit (Ab horizon) containing much disseminated charcoal at the 260-cm depth to the north. The age for charcoal sampled at station 104' was 7.6 ka and the age for charcoal sampled at station 113.5' was 8.4 ka (see main report). A correlative Ab horizon was neither observed at the 260-cm depth in this 4Btb horizon nor at the 260-cm depth in the BCt horizon of Soil Profile No. 1.] (Sample No. 05B347).

*ESTIMATED AGE:	t_o =	13 ka
	t_b =	4 ka
	t_d =	9 ky

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*Pedochronological estimates based on available information. All ages should be considered subject to ±50% variation unless otherwise indicated (Borchardt, 1992).
t_o = date when soil formation or aggradation began, ka
t_b = date when soil or strata was buried, ka
t_d = duration of soil development or aggradation, ky

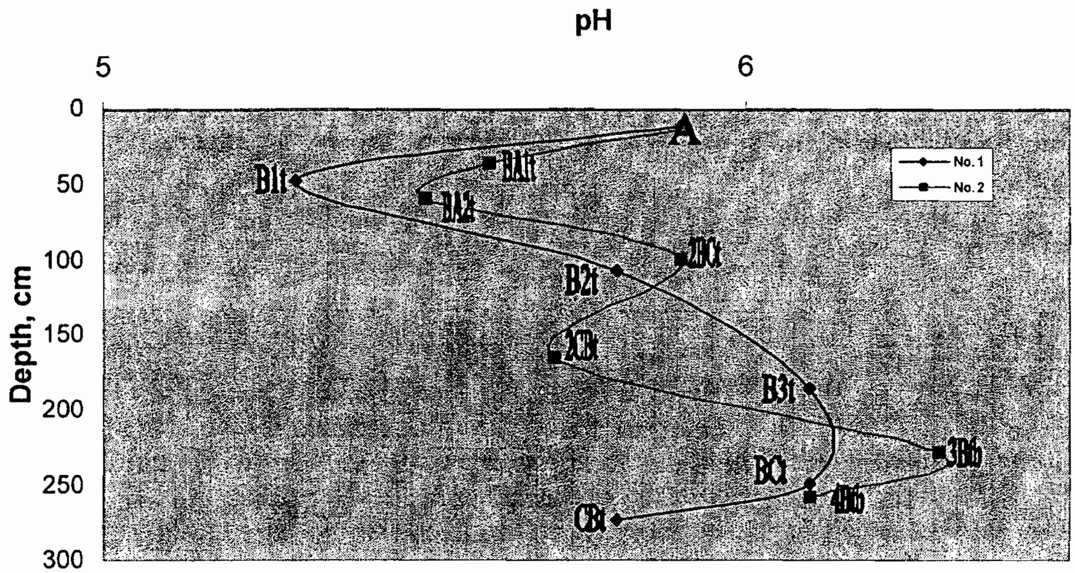

Figure 1. Soil Profile Nos. 1 and 2 in Trench ET-1 showing pH minima at about 60 cm in both profiles. Soil Profile No. 2 has a second minima at about 170 cm and

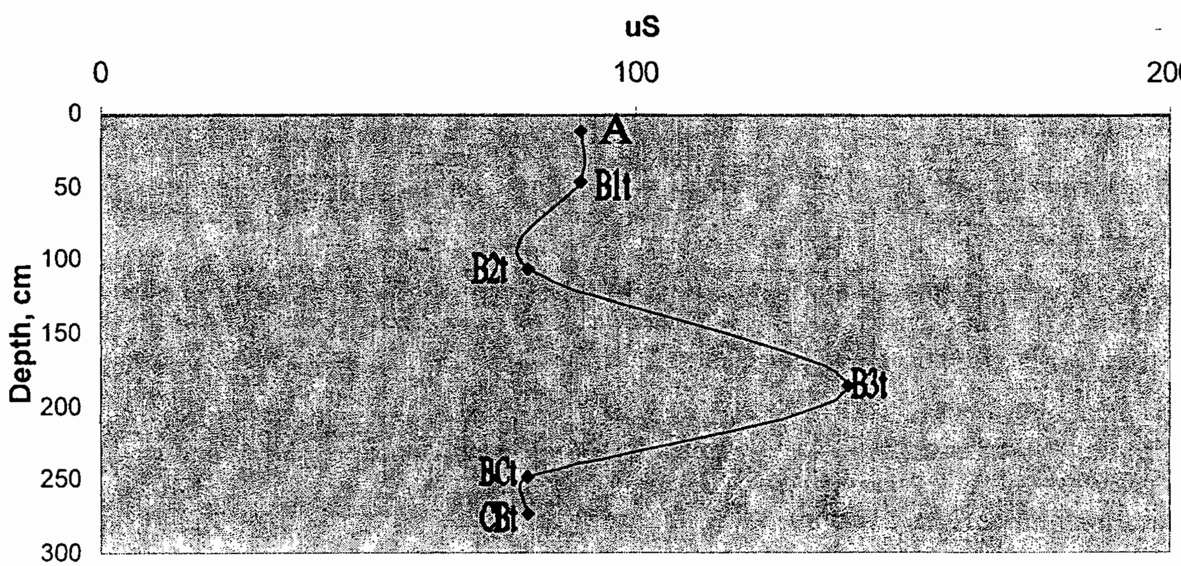

Figure 2. Soil Profile No. 1 showing an increase in conductivity (salt content) in the B3t horizon near the base of the solum.

GLOSSARY

AGE. Elapsed time in calendar years. Because the cosmic production of C-14 has varied during the Quaternary, radiocarbon years (expressed as ky B.P.) must be corrected by using tree-ring and other data. Abbreviations used for corrected ages are: ka (kilo anno or years in thousands) or Ma (millions of years). Abbreviations used for intervals are: yr (years), ky (thousands of years). radiocarbon ages = yr B.P. Calibrated ages are calculated from process assumptions, relative ages fit in a sequence, and correlated ages refer to matching units. (See also yr B.P., HOLOCENE, PLEISTOCENE, QUATERNARY, PEDOCHRONOLOGY).

AGGRADATION. A modification of the earth's surface in the direction of uniformity of grade by deposition.

ALKALI (SODIC) SOIL. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 % or more of the total exchangeable bases), or both, that plant growth is restricted.

ALKALINE SOIL. Any soil that has a pH greater than 7.3. (See Reaction, Soil.)

ANGULAR ORPHANS. Angular fragments separated from weathered, well-rounded cobbles in colluvium derived from conglomerate.

ARGILLAN. (See Clay Film.)

ARGILLIC HORIZON. A horizon containing clay either translocated from above or formed in place through pedogenesis.

ALLUVIATION. The process of building up of sediments by a stream at places where stream velocity is decreased. The coarsest particles settle first and the finest particles settle last.

ANOXIC. (See also GLEYED SOIL). A soil having a low redox potential.

AQUICLUDE. A saturated body of sediment or rock that is incapable of transmitting significant quantities of water under ordinary hydraulic gradients.

AQUITARD. A body of rock or sediment that retards but does not prevent the flow of water to or from an adjacent aquifer. It does not readily yield water to wells or springs but may serve as a storage unit for groundwater.

ATTERBERG LIMITS. The moisture content at which a soil passes from a semi-solid to a plastic state (plastic limit, PL) and from a plastic to a liquid state (liquid limit, LL). The plasticity index (PI) is the numerical difference between the LL and the PL.

BEDROCK. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

BISEQUUM. Two soils in vertical sequence, each soil containing an eluvial horizon and its underlying B horizon.

BOUDIN, BOUDINAGE. From a French word for sausage, describes the way that layers of rock break up under extension. Imagine the hand, fingers together, flat on the table, encased in soft clay and being squeezed from above, as being like a layer of rock. As the spreading clay moves the fingers (sausages) apart, the most mobile rock fractions are drawn or squeezed into the developing gaps.

BURIED SOIL. A developed soil that was once exposed but is now overlain by a more recently formed soil.

CALCAREOUS SOIL. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

CATENA. A sequence of soils of about the same age, derived from similar parent material and occurring under similar climatic conditions, but having different characteristics due to variation in relief and drainage. (See also Toposequence.)

CEC. Cation exchange capacity. The amount of negative charge balanced by positively charged ions (cations) that are exchangeable by other cations in solution (meq/100 g soil = cmol(+)/kg soil).

CLAY. As a soil separate, the mineral soil particles are less than 0.002 mm in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

CLAY FILM. A coating of oriented clay on the surface of a sand grain, pebble, soil aggregate, or ped. Clay films also line pores or root channels and bridge sand grains. Frequency classification is based on the percent of the ped faces and/or pores that contain films: very few--<5%; few--5-25%; common--25-50%; many--50-90%; and continuous--90-100%. Thickness classification is based on visibility of sand grains: thin--very fine sand grains standout; moderately thick--very fine sand grains impart microrelief to film; thick--fine sand grains enveloped by clay and films visible without magnification. Synonyms: clay skin, clay coat, argillan, illuviation cutan.

COBBLE. Rounded or partially rounded fragments of rock ranging from 7.5 to 25 cm in diameter.

COLLUVIUM. Any loose mass of soil or rock fragments that moves downslope largely by the force of gravity. Usually it is thicker at the base of the slope.

COLLUVIUM-FILLED SWALE. The prefailure topography of the source area of a debris flow.

COMPARATIVE PEDOLOGY. The comparison of soils, particularly through examination of features known to evolve through time.

CONCRETIONS. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

CONDUCTIVITY. The ability of a soil solution to conduct electricity, generally expressed as the reciprocal of the electrical resistivity. Electrical conductance is the reciprocal of the resistance (1/R = 1/ohm = ohm^{-1} = mho [reverse of ohm] = siemens = S), while electrical conductivity is the reciprocal of the electrical resistivity (EC = 1/r = 1/ohm-cm = mho/cm = S/cm or mmho/cm = dS/m). EC, expressed as uS/cm, is equivalent to the ppm of salt in solution when multiplied by 0.640. Pure rain water has an EC of 0, standard 0.01 N KCl is 1411.8 uS at 25C, and the growth of salt-sensitive crops is restricted in soils having saturation extracts with an EC greater than 2,000 uS/cm. Measurements in soils are usually performed on 1:1 suspensions containing one part by weight of soil and one part by weight of distilled water.

CONSISTENCE, SOIL. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are --

Loose.--Noncoherent when dry or moist; does not hold together in a mass.

Friable.--When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.--When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.--When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.--When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.--When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.--When dry, breaks into powder or individual grains under very slight pressure.

Cemented.--Hard and brittle; little affected by moistening.

CTPOT. Easily remembered acronym for climate, topography, parent material, organisms, and time; the five factors of soil formation.

CUMULIC. A soil horizon that has undergone aggradation coincident with its active development.

CUTAN. (See Clay Film.)

DEBRIS FLOW. Incoherent or broken masses of rock, soil, and other debris that move downslope in a manner similar to a viscous fluid.

DEBRIS SLOPE. A constant slope with debris on it from the free face above.

DEGRADATION. A modification of the earth's surface by erosion.

DURIPAN. A subsurface soil horizon that is cemented by illuvial silica, generally deposited as opal or microcrystalline silica, to the degree that less than 50 percent of the volume of air-dry fragments will slake in water or HCl.

ELUVIATION. The removal of soluble material and solid particles, mostly clay and humus, from a soil horizon by percolating water.

EOLIAN. Deposits laid down by the wind, landforms eroded by the wind, or structures such as ripple marks made by the wind.

FAULT-LINE SCARP. A scarp that has been produced by differential erosion along an old fault line.

FIRST-ORDER DRAINAGE. The most upstream, field-discernible concavity that conducts water and sediments to lower parts of a watershed.

FLOOD PLAIN. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

FOSSIL FISSURE. A buried rectilinear chamber associated with extension due to ground movement. The chamber must be oriented along the strike of the shear and must have vertical and horizontal dimensions greater than its width. It must show no evidence of faunal activity and its walls may have silt or clay coatings indicative of frequent temporary saturation with ground water. May be mistaken for an animal burrow. Also known as a paleofissure.

FRIABILITY. Term for the ease with which soil crumbles. A friable soil is one that crumbles easily.

GENESIS, SOIL. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum (A and B horizons) from the unconsolidated parent material.

GEOMORPHIC. Pertaining to the form of the surface features of the earth. Specifically, geomorphology is the analysis of landforms and their mode of origin.

GLEYED SOIL. A soil having one or more neutral gray horizons as a result of water logging and lack of oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent water logging.

GRAVEL. Rounded or angular fragments of rock 2 to 75 mm in diameter. Soil textures with >15% gravel have the prefix "gravelly" and those with >90% gravel have the suffix "gravel."

HIGHSTAND. The highest elevation reached by the ocean during an interglacial period.

HOLOCENE. The most recent epoch of geologic time, extending from 10 ka to the present.

HORIZON, SOIL. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major soil horizons:

O horizon.--The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.--The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

E horizon -- This eluvial horizon is light in color, lying beneath the A horizon and above the B horizon. It is made up mostly of sand and silt, having lost most of its clay and iron oxides through reduction, chelation, and translocation.

B horizon.--The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these.

C horizon.--The relatively unweathered material immediately beneath the solum. Included are sediment, saprolite, organic matter, and bedrock excavatable with a spade. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a number precedes the letter C.

R layer.--Consolidated rock not excavatable with a spade. It may contain a few cracks filled with roots or clay or oxides. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

These lower-case letters may be appended:

-a	Mostly decomposed organic matter; rubbed fiber content is than 17%.
-b	Buried soil horizon. If more than one buried soil exists, this letter is followed by an Arabic number indicating the sequence.
-c	Concretions or nodules cemented by iron, aluminum, manganese, or titanium.
-d	Dense horizon physically restricting root penetration.
-e	Intermediately decomposed organic matter; rubbed fiber content is between 17 and 40%.
-f	Frozen horizon cemented by permanent ice.
-g	Gleyed horizon in which iron has been removed during soil formation or saturation with stagnant water has preserved a reduced state. Strong gleying is indicated by chromas of one or less, and hues bluer than 10Y. Bg is used for a horizon with pedogenic features in addition to gleying, while Cg is not.
-h	Humus. Illuvial accumulation of amorphous organic matter-sesquioxide complexes that either coat grains, form pellets, or form sufficient coatings and pore fillings to cement the horizon.
-i	Least decomposed organic matter; rubbed fiber content is greater than 40%.
-j	Used in combination with another horizon designation (e.g., Btj, Ej) to denote incipient development of that feature.
-k	Carbonates. Illuvial accumulation of alkaline earth carbonates, mainly calcium carbonate; the properties do not meet those for the K horizon.
-l	Unused as of 1992.
-m	Cemented. Horizon that is more than 90% cemented. Denote cementing material (zm, soluble salts; ym, gypsum; km, carbonate; sm, iron; kqm, carbonate and silica)
-n	Sodium. Accumulation of exchangeable sodium.
-o	Oxides. Residual accumulation of sesquioxides.
-p	Plowed or otherwise disturbed by *Homo sapiens* or domesticated animals.
-q	Silica (secondary) accumulation.
-r	Rock weathered in place. Saprolite.
-s	Sesquioxides. Illuvial accumulation of sesquioxides with color value and chroma greater than three.
-ss	Slickensides
-t	Accumulation of silicate clay that has either formed in place or has been translocated from above. Only used with B horizons.
-u	Unweathered.
-v	Plinthite. Iron-rich, reddish material that hardens irreversibly when dried.
-w	Development of color (redder hue or higher chroma relative to C) or structure with little or no apparent illuvial accumulation of material.
-x	Fragipan. Subsurface horizon characterized by a bulk density greater than that of the overlying soil, hard to very hard consistence, brittleness, and seemingly cemented when dry.
-y	Gypsum. Accumulation of gypsum.
-z	Salts. Accumulation of salts more soluble than gypsum.

HUMUS. The well-decomposed, more or less stable part of the organic matter in mineral soils.

ILLUVIATION. The deposition by percolating water of solid particles, mostly clay or humus, within a soil horizon.

INTERFLUVE. The land lying between streams.

ISOCHRONOUS BOUNDARY. A gradational boundary between two sedimentary units indicating that they are approximately the same age. Opposed to a nonisochronous boundary, which by its abruptness indicates that it delineates units having significant age differences.

KROTOVINA. An animal burrow filled with soil.

LEACHING. The removal of soluble material from soil or other material by percolating water.

LOWSTAND. The lowest elevation reached by the ocean during a glacial period.

MANGAN. A thin coating of manganese oxide (cutan) on the surface of a sand grain, pebble, soil aggregate, or ped. Mangans also line pores or root channels and bridge sand grains.

MORPHOLOGY, SOIL. The physical make-up of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

MOTTLING, SOIL. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: abundance--few, common, and many; size--fine, medium, and coarse; and contrast--faint, distinct and prominent. The size measurements are these: fine, less than 5 mm in diameter along the greatest dimension; medium, from 5 to 15 mm, and coarse, more than 15 mm.

MRT (MEAN RESIDENCE TIME.) The average age of the carbon atoms within a soil horizon. Under ideal reducing conditions, the humus in a soil will have a C-14 age that is half the true age of the soil. In oxic soils humus is typically destroyed as fast as it is produced, generally yielding MRT ages no older than 300-1000 years, regardless of the true age of the soil.

MUNSELL COLOR NOTATION. Scientific description of color determined by comparing soil to a Munsell Soil Color Chart (Available from Macbeth Division of Kollmorgen Corp., 2441 N. Calvert St., Baltimore, MD 21218). For example, dark yellowish brown is denoted as 10YR3/4m in which the 10YR refers to the hue or proportions of yellow and red, 3 refers to value or lightness (0 is black and 10 is white), 4 refers to chroma (0 is pure black and white and 20 is the pure color), and m refers to the moist condition rather than the dry (d) condition.

OVERBANK DEPOSIT. Fine-grained alluvial sediments deposited from floodwaters outside of the fluvial channel.

OXIC. A soil having a high redox potential. Such soils typically are well drained, seldom being waterlogged or lacking in oxygen. Rubification in such soils tends to increase with age.

PALEOSEISMOLOGY. The study of prehistoric earthquakes through the examination of soils, sediments, and rocks.

PALEOSOL. A soil that formed on a landscape in the past with distinctive morphological features resulting from a soil-forming environment that no longer exists at the site. The former pedogenic process was either altered because of external environmental change or interrupted by burial.

PALINSPASTIC RECONSTRUCTION. Diagrammatic reconstruction used to obtain a picture of what geologic and/or soil units looked like before their tectonic deformation.

PARENT MATERIAL. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

PED. An individual natural soil aggregate, such as a granule, a prism, or a block.

PEDOCHRONOLOGY. The study of pedogenesis with regard to the determination of when soil formation began, how long it occurred, and when it stopped. Also known as soil dating. Two ages and the calculated duration are important:

t_o = age when soil formation or aggradation began, ka
t_b = age when the soil or stratum was buried, ka
t_d = duration of soil development or aggradation, ky

Pedochronological estimates are based on available information. All ages should be considered subject to $\pm$50% variation unless otherwise indicated.

PEDOCHRONOPALEOSEISMOLOGY. The study of prehistoric earthquakes by using pedochronology.

PEDOLOGY. The study of the process through which rocks, sediments, and their constituent minerals are transformed into soils and their constituent minerals at or near the surface of the earth.

PEDOGENESIS. The process through which rocks, sediments, and their constituent minerals are transformed into soils and their constituent minerals at or near the surface of the earth.

PERCOLATION. The downward movement of water through the soil.

pH VALUE. The negative log of the hydrogen ion concentration. Measurements in soils are usually performed on 1:1 suspensions containing one part by weight of soil and one part by weight of distilled water. A soil with a pH of 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid or "sour" soil is one that gives an acid reaction; an alkaline soil is one that gives an alkaline reaction. In words, the degrees of acidity or alkalinity are expressed as:

Extremely acid------- <4.5
Very strongly acid--- 4.5 to 5.0
Strongly acid-------- 5.1 to 5.5
Medium acid---------- 5.6 to 6.0
Slightly acid-------- 6.1 to 6.5
Neutral-------------- 6.6 to 7.3
Mildly alkaline------ 7.4 to 7.8
Moderately alkaline-- 7.9 to 8.4
Strongly alkaline---- 8.5 to 9.0
Very strongly alkaline >9.0

Used if significant:
Very slightly acid--- 6.6 to 6.9
Very mildly alkaline- 7.1 to 7.3

PHREATIC SURFACE. (See Water Table.)

PLANATION. The process of erosion whereby a portion of the surface of the Earth is reduced to a fundamentally even, flat, or level surface by a meandering stream, waves, currents, glaciers, or wind.

PLEISTOCENE. An epoch of geologic time extending from 10 ka to 1.8 Ma; it includes the last Ice Age.

PROFILE, SOIL. A vertical section of the soil through all its horizons and extending into the parent material.

QUATERNARY. A period of geologic time that includes the past 1.8 Ma. It consists of two epochs--the Pleistocene and Holocene.

PROGRADATION. The building outward toward the sea of a shoreline or coastline by nearshore deposition.

RELICT SOIL. A surface soil that was partly formed under climatic conditions significantly different from the present.

RUBIFICATION. The reddening of soils through the release and precipitation of iron as an oxide during weathering. Munsell hues and chromas of well-drained soils generally increase with soil age.

SALINE SOIL. A soil that contains soluble salts in amounts that impair the growth of crop plants but that does not contain excess exchangeable sodium.

SAND. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 mm. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

SECONDARY FAULT. A minor fault that bifurcates from or is associated with a primary fault. Movement on a secondary fault never occurs independently of movement on the primary, seismogenic fault.

SHORELINE ANGLE. The line formed by the intersection of the wave-cut platform and the sea cliff. It approximates the position of sea level at the time the platform was formed.

SILT. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 mm) to the lower limit of very find sand (0.05 mm.) Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

SLICKENSIDES. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may form along a fault plane; at the bases of slip surfaces on steep slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

SLIP RATE. The rate at which the geologic materials on the two sides of a fault move past each other over geologic time. The slip rate is expressed in mm/yr, and the applicable duration is stated. Faults having slip rates less than 0.01 mm/yr are generally considered inactive, while faults with Holocene slip rates greater than 0.1 mm/yr generally display tectonic geomorphology.

SMECTITE. A fine, platy, aluminosilicate clay mineral that expands and contracts with the absorption and loss of water. It has a high cation-exchange capacity and is plastic and sticky when moist.

SOIL. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

SOIL SEISMOLOGIST. Soil scientist who studies the effects of earthquakes on soils.

SOIL TECTONICS. The study of the interactions between soil formation and tectonism.

SOIL TONGUE. That portion of a soil horizon extending into a lower horizon.

SOLUM. Combined A and B horizons. Also called the true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

STONE LINE. A thin, buried, planar layer of stones, cobbles, or bedrock fragments. Stone lines of geological origin may have been deposited upon a former land surface. The fragments are more often pebbles or cobbles than stones. A stone line generally overlies material that was subject to weathering, soil formation, and erosion before deposition of the overlying material.

Many stone lines seem to be buried erosion pavements, originally formed by running water on the land surface and concurrently covered by surficial sediment

STRATH TERRACE. A gently sloping terrace surface bearing little evidence of aggradation.

STRUCTURE, SOIL. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are--platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

SUBSIDIARY FAULT. A branch fault that extends a substantial distance from the main fault zone.

TECTOTURBATION. Soil disturbance resulting from tectonic movement.

TEXTURE, SOIL. Particle size classification of a soil, generally given in terms of the USDA system which uses the term "loam" for a soil having equal properties of sand, silt, and clay. The basic textural classes, in order of their increasing proportions of fine particles are sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sand clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

TOPOSEQUENCE. A sequence of kinds of soil in relation to position on a slope. (See also Catena.)

TRANSLOCATION. The physical movement of soil particles, particularly fine clay, from one soil horizon to another under the influence of gravity.

UNIFIED SOIL CLASSIFICATION SYSTEM. The particle size classification system used by the U.S. Army Corps of Engineers and the Bureau of Reclamation. Like the ASTM and AASHO systems, the sand/silt boundary is at 80 um instead of 50 um used by the USDA and FAA. Unlike all other systems the gravel/sand boundary is at 4 mm instead of 2 mm and the silt/clay boundary is determined by using Atterberg limits.

VERTISOL. A soil with at least 30% clay, usually smectite, that fosters pronounced changes in volume with change in moisture. Cracks greater than 1 cm wide appear at a depth of 50 cm during the dry season each year. One of the ten USDA soil orders.

WATER TABLE. The upper limit of the soil or underlying rock material that is wholly saturated with water. Also called the phreatic surface.

WAVE-CUT PLATFORM. The relatively smooth, slightly seaward-dipping surface formed along the coast by the action of waves generally accompanied by abrasive materials.

WEATHERING. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

yr B.P. Uncorrected radiocarbon age expressed in years before present, calculated from 1950. Calendar-corrected ages are expressed in ka, or, if warranted, as A.D. or B.C.

APPENDIX C

GEOCHRON LABORATORIES

Radiocarbon Age Determination

STUIVER AND REIMER, 2005

Radiocarbon Calibration Program

GEOCHRON LABORATORIES

a division of Krueger Enterprises, Inc.

711 Concord Avenue ✦ Cambridge, Massachusetts 02138-1002 ✦ USA
t (617) 876-3691 f (617) 661-0148 www.geochronlabs.com

RADIOCARBON AGE DETERMINATION

REPORT OF ANALYTICAL WORK

Our Sample No. **GX-32066-AMS**

Date Received: 10/19/2005

Your Reference:

Date Reported: 01/23/2006

Submitted by: Anthony Schuetze
ENGEO Inc.
6288 San Ignacio Avenue, Suite A
San Jose, CA 95119

Sample Name: **C-2**

AGE = **7520 ± 50 ^{14}C years BP (^{13}C corrected)**

Description: Sample of charcoal

Pretreatment: The charcoal fragments were separated from sand, silt, rootlets, or other foreign matter. The sample was then treated with hot dilute 1N HCl to remove any carbonates; with 0.1N dilute NaOH to remove humic acids and other organic contaminants; and a second time with dilute HCl. The sample was then rinsed and dried and the cleaned charcoal was combusted to recover carbon dioxide for the analysis.

Comments:

$\delta^{13}C_{PDB}$ = **-27.8 ‰**

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error is +/- 1 s as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.

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t (617) 876-3691 **f** (617) 661-0148 www.geochronlabs.com

RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No.	**GX-32067-AMS**	Date Received:	10/19/2005
Your Reference:		Date Reported:	01/23/2006

Submitted by: Anthony Schuetze
ENGEO Inc.
6288 San Ignacio Avenue, Suite A
San Jose, CA 95119

Sample Name: **C-3**

AGE = **6600 ± 60 ^{14}C years BP (^{13}C corrected)**

Description: Sample of charcoal

Pretreatment: The charcoal fragments were separated from sand, silt, rootlets, or other foreign matter. The sample was then treated with hot dilute 1N HCl to remove any carbonates; with 0.1N dilute NaOH to remove humic acids and other organic contaminants; and a second time with dilute HCl. The sample was then rinsed and dried and the cleaned charcoal was combusted to recover carbon dioxide for the analysis.

Comments:

$\delta^{13}C_{PDB}$ = **-25.5 ‰**

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error is +/- 1 s as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No.	**GX-32068-AMS**	Date Received:	10/19/2005
Your Reference:		Date Reported:	01/23/2006

Submitted by: Anthony Schuetze
ENGEO Inc.
6288 San Ignacio Avenue, Suite A
San Jose, CA 95119

Sample Name: **C-5**

AGE = **4160 ± 50 ^{14}C years BP (^{13}C corrected)**

Description: Sample of charcoal

Pretreatment: The charcoal fragments were separated from sand, silt, rootlets, or other foreign matter. The sample was then treated with hot dilute 1N HCl to remove any carbonates; with 0.1N dilute NaOH to remove humic acids and other organic contaminants; and a second time with dilute HCl. The sample was then rinsed and dried and the cleaned charcoal was combusted to recover carbon dioxide for the analysis.

Comments:

$\delta^{13}C_{PDB}$ = **-27.9 ‰**

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error is +/- 1 s as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.

The age is referenced to the year A.D. 1950.

RADIOCARBON CALIBRATION PROGRAM*

CALIB REV5.0.2

*To be used in conjunction with:

Stuiver, M., and Reimer, P.J., 1993, Radiocarbon, 35, 215-230.

Annotated results (text) - -

Export file - c14res.csv

C-5

Lab Code

Sample Description (80 chars max)

Radiocarbon Age BP 4160 +/- 50

Calibration data set: intcal04.14c # Reimer et al. 2004

% area enclosed	cal AD age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 2873- 2839	0.200
	2814- 2676	0.800
95.4 (2 sigma)	cal BC 2886- 2619	0.973
	2608- 2599	0.014
	2593- 2585	0.013

References for calibration datasets:

PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, C Bertrand, PG Blackwell, CE Buck, G Burr, KB Cutler, PE Damon, RL Edwards, RG Fairbanks, M Friedrich, TP Guilderson, KA Hughen, B Kromer, FG McCormac, S Manning, C Bronk Ramsey, RW Reimer, S Remmele, JR Southon, M Stuiver, S Talamo, FW Taylor, J van der Plicht, and CE Weyhenmeyer (2004), Radiocarbon 46:1029-1058.

Comments:

* This standard deviation (error) includes a lab error multiplier.

** 1 sigma = square root of (sample std. dev.^2 + curve std. dev.^2)

** 2 sigma = 2 x square root of (sample std. dev.^2 + curve std. dev.^2)

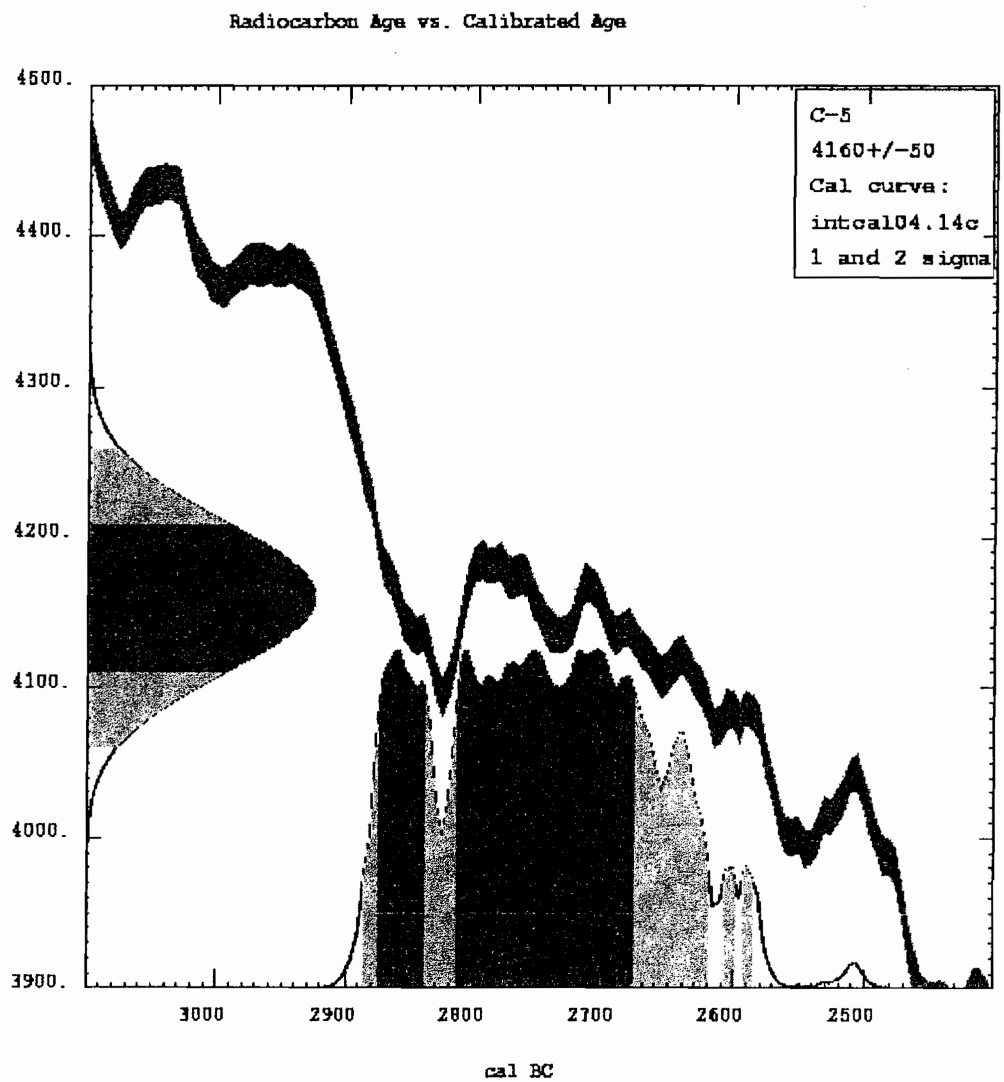
where ^2 = quantity squared.

[ ] = calibrated range impinges on end of calibration data set

0* represents a "negative" age BP

1955* or 1960* denote influence of nuclear testing C-14

NOTE: Cal ages and ranges are rounded to the nearest year which may be too precise in many instances. Users are advised to round results to the nearest 10 yr for samples with standard deviation in the radiocarbon age greater than 50 yr.


Radiocarbon Age vs. Calibrated Age
C-5
4160+/-50
Cal curve:
intcal04.14c
1 and 2 sigma
4500.
4400.
4300.
4200.
4100.
4000.
3900.
3000
2900
2800
2700
2600
2500
cal BC

RADIOCARBON CALIBRATION PROGRAM*
CALIB REV5.0.2

*To be used in conjunction with:
Stuiver, M., and Reimer, P.J., 1993, Radiocarbon, 35, 215-230.
Annotated results (text) - -
Export file - c14res.csv

C-2
Lab Code
Sample Description (80 chars max)
Radiocarbon Age BP 7520 +/- 50
Calibration data set: intcal04.14c # Reimer et al. 2004

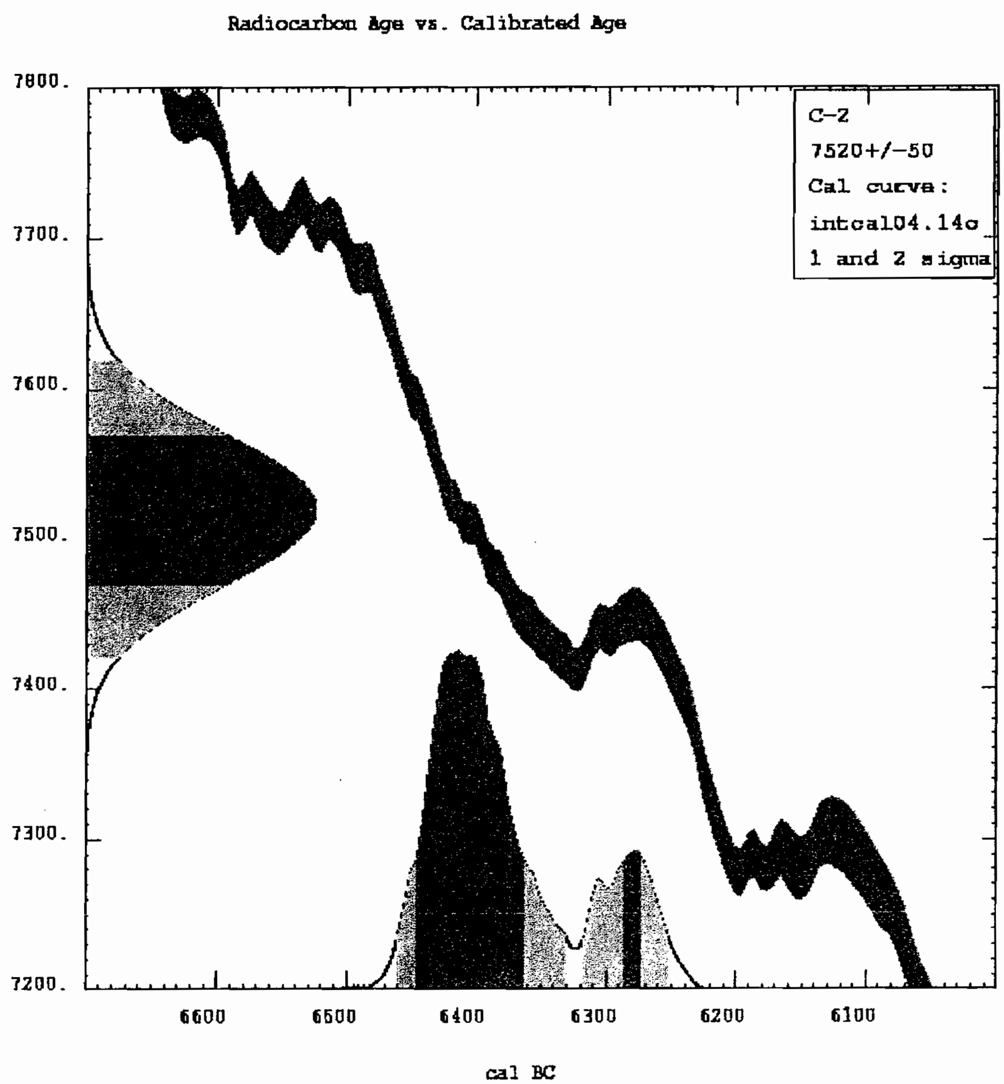
% area enclosed under	cal AD age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 6446- 6363	0.925
	6285- 6273	0.075
95.4 (2 sigma)	cal BC 6461- 6330	0.791
	6317- 6252	0.209

References for calibration datasets:

PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, C Bertrand, PG Blackwell, CE Buck, G Burr, KB Cutler, PE Damon, RL Edwards, RG Fairbanks, M Friedrich, TP Guilderson, KA Hughen, B Kromer, FG McCormac, S Manning, C Bronk Ramsey, RW Reimer, S Remmele, JR Southon, M Stuiver, S Talamo, FW Taylor, J van der Plicht, and CE Weyhenmeyer (2004), Radiocarbon 46:1029-1058.

Comments:
* This standard deviation (error) includes a lab error multiplier.
** 1 sigma = square root of (sample std. dev.^2 + curve std. dev.^2)
** 2 sigma = 2 x square root of (sample std. dev.^2 + curve std. dev.^2)
where ^2 = quantity squared.
[ ] = calibrated range impinges on end of calibration data set
0* represents a "negative" age BP
1955* or 1960* denote influence of nuclear testing C-14

NOTE: Cal ages and ranges are rounded to the nearest year which may be too precise in many instances. Users are advised to round results to the nearest 10 yr for samples with standard deviation in the radiocarbon age greater than 50 yr.



Radiocarbon Age vs. Calibrated Age
C-Z
7520+/-50
Cal curve:
intcal04.14c
1 and 2 sigma
7800.
7700.
7600.
7500.
7400.
7300.
7200.
6600
6500
6400
6300
6200
6100
cal BC

RADIOCARBON CALIBRATION PROGRAM*
CALIB REV5.0.2

*To be used in conjunction with:
Stuiver, M., and Reimer, P.J., 1993, Radiocarbon, 35, 215-230.
Annotated results (text) - -
Export file - c14res.csv

C-3
Lab Code
Sample Description (80 chars max)
Radiocarbon Age BP 6600 +/- 60
Calibration data set: intcal04.14c # Reimer et al. 2004

% area enclosed under	cal AD age ranges	relative area under probability distribution
68.3 (1 sigma)	cal BC 5611- 5591	0.219
	5564- 5490	0.781
95.4 (2 sigma)	cal BC 5630- 5475	1.000

References for calibration datasets:
PJ Reimer, MGL Baillie, E Bard, A Bayliss, JW Beck, C Bertrand, PG Blackwell, CE Buck, G Burr, KB Cutler, PE Damon, RL Edwards, RG Fairbanks, M Friedrich, TP Guilderson, KA Hughen, B Kromer, FG McCormac, S Manning, C Bronk Ramsey, RW Reimer, S Remmele, JR Southon, M Stuiver, S Talamo, FW Taylor, J van der Plicht, and CE Weyhenmeyer (2004), Radiocarbon 46:1029-1058.

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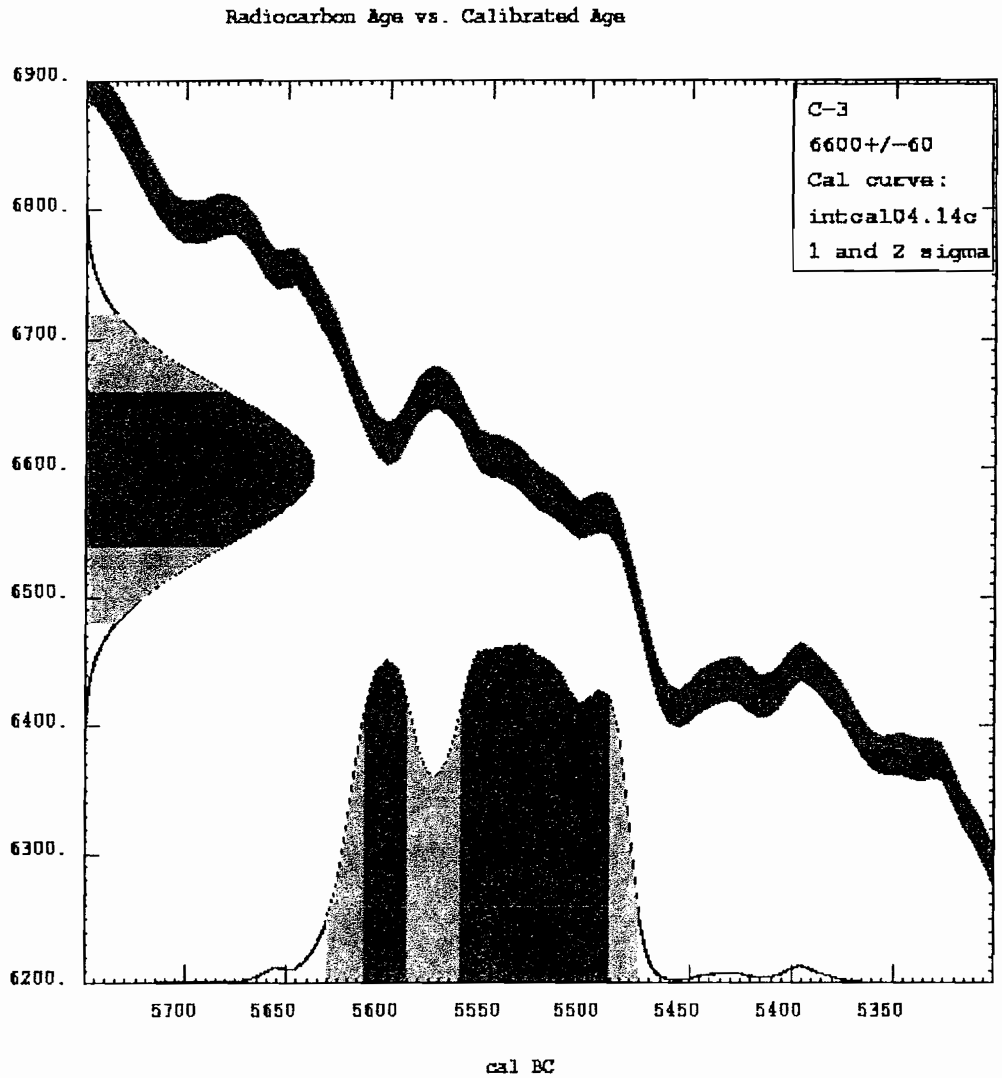
Radiocarbon Age vs. Calibrated Age
C-3
6600+/-60
Cal curve:
intcal04.14c
1 and 2 sigma
6900.
6800.
6700.
6600.
6500.
6400.
6300.
6200.
5700
5650
5600
5550
5500
5450
5400
5350
cal BC